Popular Astronomy.

Vol. XX, No.9. NOVEMBER, 1912. Whole No., 199

THE RECENT DISTURBANCE IN THE NORTHERN EQUATORIAL BELT OF JUPITER.

LATIMER J. WILSON,
Director of the Planetary and Lunar Section.

An observation of Jupiter made here on August 30 with an eleven inch reflector disclosed an unusual darkening of the northern equatorial belt. The longitude of the center of the disc at the time of observation was 274° for system II, and the dark marking was then very near the preceding limb of the planet. On September 1, the dark spot was on the Central Meridian and its longitude was 159.8° for its following part. The arrows at the bottom of the maps (Plate XXVII) indicate the position of the dark area at the given dates. The passage of the disturbance seems to be even more rapid than required for System I, but it is in the latitude belonging to System II. At the last observation, Sept. 20, when longitude 101° was central, the dark condensation was approaching the preceding limb, and the northern equatorial belt immediately following was darker than it has been during the greater part of the present apparition. The effect of the disturbance seems to be a partial clearing away of the white matter which has obscured the belt. The part preceding the disturbance or that preceding longitude 10°, as seen on Sept. 19, is as faint as usual. It will be interesting to see if this means the opening or darkening of the entire belt.

Details are lacking in the second map because of rather bad seeing since the first of the month.

I am indebted to Mr. J. J. Schafer and Mr. Hibbert Perceval Newton, members of the Planetary and Lunar Section of the Society for Practical Astronomy, for corroboration in observing this new marking. Mr. Schafer recorded an observation of it on August 23.

Note:—With better seeing the longitude of the preceding part of the Red Spot Bay as obtained with a Wray three-and-three-eighths-inch refractor on October 1 was found to be 283°. Unfortunately the larger telescopes could not be used to confirm this, but the definition was so good that there is little reason to doubt that the result is more reliable than that indicated

on map 2. At the date of writing, Oct. 7, the following part of the disturbance in the N. Eq. belt terminates in an intensely dark spot in longitude 112°.3. (II) It is the darkest marking in sight. The longitude of the preceding part of the disturbance in this belt as obtained on Oct. 5 was 185°.2, indicating that the belt is undergoing a great change for a stretch of more than 287°, the preceding part of the dark area having made a revolution around the planet since Aug. 23. A seven-inch reflector with a magnification of 200 diameters was used.

1405 Gartland Ave.
Nashville, Tenn. Sept. 23, 1912.

HELIUM STARS HAVING BRIGHT LINES IN THEIR SPECTRA.*

PAUL W. MERRILL.

Nearly all of the brighter stars, and doubtless also of the fainter ones, may be considered as having a compact nucleus which radiates like a solid or liquid, surrounded by an atmosphere of various elements, each of which absorbs characteristic groups of wave-lengths. These outer gases themselves may be glowing, but they absorb more light than they emit, and give the spectrum the appearance of being crossed by dark bands.

At Harvard the commoner kinds of stellar spectra have been classified† as follows:—

B	helium stars	blue or white
A	hydrogen stars	
F	intermediate stage	yellow
G	solar stars	
K	post-solar	red
M	banded spectra	

The number of dark lines and the completeness of absorption increase as we go along the list. It is the idea of astronomers that, in general, a star runs the whole gamut of these types, though the time required is unthinkably long. One generation of observers is insufficient to detect the progression. Dr. Campbell's discovery‡ that the average radial velocities of a large

* [Reprinted from *Publications of the Astronomical Society of the Pacific*, August, 1912.]

† Harvard College Observatory *Annals*, Vol. 28.

‡ Silliman Lecture, Yale University, January 31, 1910.

number of stars, if grouped by spectral types, increase from B to M, as listed above, makes it reasonably certain that the order is correct. Professor Wilson has recently shown* that this rule holds for total motion in space where this is known, and there is confirmatory evidence in the data of spectroscopic binaries†.

From considerations just referred to, B type stars are known as "early." The absorption of hydrogen and helium is predominant and characteristic. Other lines are often present, though usually faint, e.g., those of oxygen, silicon, magnesium. These stars are not distributed equally over the sky, even relatively, but are found in the greatest numbers in or near the Milky Way.

This important element helium occurs also in the chromosphere of the sun; it forms four or five parts of every million of the earth's atmosphere; it is found widely distributed in the earth's crust, but practically always occluded in radio-active minerals. Next to hydrogen, it is the lightest of the elements. It is perfectly inert chemically.

From a masterly experiment by Rutherford,‡ we know conclusively that when an atom of radium disintegrates it gives off an atom of helium. At first it is in a peculiar condition, owing to the high velocity of expulsion and to an electrical charge which it carries, but in a short time it is found to be nothing more nor less than ordinary inert helium. There are good grounds for believing that all of the helium in the earth has come into existence from radio-active substances in this sensational fashion. Such a remark with reference to the stars would be a pure speculation, though not an uninteresting, and possibly not even an unprofitable one. Just at this writing comes the announcement from Küstner¶ that uranium, and the direct product of radium called emanation, are making their marks in the spectrum of Enebo's nova in *Gemini*. The lines of helium are present.

In 1866 Secchi discovered a peculiarity in one of these helium stars. In examining the spectrum of γ *Cassiopeiae* ($\alpha = 0^h\ 50^m.7$), he saw that it contained *emission* lines of hydrogen. Since then so many similar objects have been found that they

---

* Lick Observatory *Bulletin*, No. 214, and *Publications A.S.P.*, June 1912.

† *Lick Observatory Bulletin*, No. 181.

‡ *Philosophical Magazine*, **17**, 1909 p. 281.

¶ Harvard College Observatory *Circular*, No. 492.

are considered as a sub-class.* They have been called to the attention of astronomers principally by the lists of Harvard College Observatory† and the observations of Campbell ‡ at Mount Hamilton. The number known is at least sixty three, being divided according to brightness as follows:—

Brighter than 3.0 magnitude	5
3.0 to 5.0 magnitude	29
Fainter than 5.0 magnitude	28
Variable	1

Within the range of spectroscopic surveys there are less than nine hundred Class B stars. The proportion of the bright-line stars to the whole class is not inconsiderable, particularly in view of the fact that it is probable that numerous existing cases have not been detected.

Though the glowing hydrogen of the atmosphere absorbs light from the nucleus, it may well be that in some cases it emits more than it absorbs, when, of course, the lines will appear bright on a continuous background. In many and perhaps all instances the bright lines are accompanied by broad absorption bands whose centers have about the same positions. This is explainable without great difficulty if we may consider the outer portions of the hydrogen layer as the most brilliant. This assumption is not extreme, as other conditions than temperature are known to affect light radiation. The lower levels under great pressure may furnish the broad absorption band, with a narrower bright line within from the upper gas. The observed absorption varies in different stars from almost completeness to none at all or to a quantity so small as not to be readily discernible. Similarly, the bright lines vary from striking intensity to the faintest indications.

The following statements are quoted from Dr. Campbell's description¶ of his observations of bright hydrogen lines in stellar spectra:—

(a) Some stars contain both bright and dark hydrogen lines.

(b) The bright lines in such stars are those of greater wave-length; the dark lines are those of shorter wave-length.

---

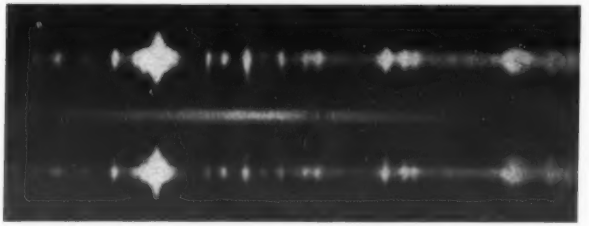
* Vogel's Class Ic. Miss Clerke, "Problems in Astrophysics," Part II Chapter 9.

† The latest list, including all previous ones, is Harvard College Observatory *Annals* **56**, p. 182.

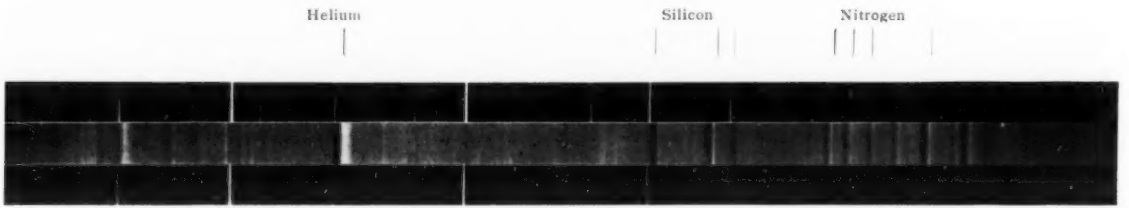
‡ *Astrophysical Journal* **2**, p. 177.

¶ *Astrophysical Journal* **2**, p. 177.

PLATE XXVIII.



SPECTRUM OF b^2 CYGNI 1911, JUNE 21, SHOWING A BRIGHT LINE SUPERPOSED ON AN ABSORPTION Hβ.



SPECTRUM OF P CYGNI 1911, JULY 3, SHOWING BOTH BRIGHT AND DARK LINES.

(c) The intensities of the bright lines decrease as we approach the violet.

(d) The intensities of the dark lines increase as we approach the violet.

In the same spectrum the various hydrogen lines may present appearances which differ widely. For instance, the red line may be bright, one or two succeeding ones both dark and bright, and the remainder of the series toward the violet dark. This is, of course, in accord with the above rules in cases where the dark and bright series of lines overlap in the central part of the spectrum.

I am not acquainted with a single certain exception to rule (c) for Class B stars, but it does not hold for all the stars having bright hydrogen lines. In fact, great differences of intensity are found in the *reverse order*. The star R *Leonis* (Type Md, $\alpha = 9^h\ 42^m.2$) is an example in point.

In many instances the bright lines superposed on the absorption bands are double. The components do not coalesce periodically as do lines of spectroscopic binaries where two spectra are visible, but remain permanently apart. A number of stars have periodic displacements of the lines as a whole, which have placed them in the list of binaries. Sometimes the bright lines are present merely as intensified borders to the dark line,* but more commonly they lie entirely within it. There may or may not be a more or less regular change of appearance, though the former is of rather rare occurrence. A notable example is Φ *Persei* † ($\alpha = 1^h\ 37^m.4$). In 1905 Hβ was dark in *Pleione* ($\alpha = 3^h\ 43^m.3$), though it had often been observed, previously, as bright. Changes have been recognized in the hydrogen lines of ν *Sagittarii* ($\alpha = 19^h\ 16^m.0$), a star which has a composite spectrum.

In some stars, lines other than those due to hydrogen show bright. Here again there may be variability, even when the hydrogen lines are unchanging. There were early observations of bright D_3 γ *Cassiopeiae* ($\alpha = 0^h\ 50^m.7$), but in 1889 with the thirty-six inch telescope at the Lick Observatory Keeler saw no trace of either dark or bright lines in that region. The introduction of photography in stellar spectroscopy has frequently failed to confirm suspicions of variability based upon non-accordant visual observations. Very small weight should be

* Hγ of Φ Persei. Hβ and Hγ of β *Monocerotis*.

† Ludendorff, *Astronomische Nachrichten* **186**, p. 16. J. B. Cannon *Journal Royal Astronomical Society of Canada*, Vol. 4, p. 195.

attached to visual observations by any other than the most competent observers. The few absorption lines in these stars are generally very weak, as would be expected, since if some elements give emission lines, it is improbable that the absorption of other elements should strongly overpower their radiation. The absorption lines of the binary ϵ *Capricorni* ($\alpha = 21^h\ 31^m.5$) are variable.

There is, then, a subdivision of Class B stars having double bright hydrogen lines superposed more or less symmetrically on the corresponding absorption bands. No explanation of this phenomenon is at hand. There are other features also, as indicated above, whose causes are not clear. Besides this group there are a few anomalous specimens of which one or two must be mentioned.

Perhaps the most complex stellar spectrum thus far observed is that of the well-known doubly eclipsing variable β *Lyræ* ($\alpha = 18^h\ 46^m.4$). The observations of it would fill volumes, and no details can be given here except to say that there are both bright and dark lines which change with baffling complication. A quadruple system is suggested by Curtiss;* the reader is referred to his extensive discussion.

The spectrum of P *Cygni*† ($\alpha = 20^h\ 14^m.1$) resembles that of a nova in having bright and dark lines apparently side by side, the emission line lying toward the red. The star is in fact a nova, having appeared in the year 1600. The light curve is that of a typical nova, except that the fluctuations were separated by years instead of days, and the fact that the final magnitude is the fifth instead of the twelfth or fifteenth. There are bright lines accompanied by absorption in all parts of the spectrum, from the ultra violet to beyond Hα. This remarkable spectrum continues year after year without appreciable change.

Descriptions of nearly all the stars mentioned in this paper can be found in Harvard College Observatory *Annals*, Vol. 28.

There is an interesting general question in regard to these stars which the future may answer. Are they an offshoot from the tree of stellar evolution? Or are they in the line of regular progression, but few in number because the time of passage through this condition is comparatively short; or because most of the stars have passed this stage in the process of development and there is a paucity of recruits?

Mount Hamilton, Cal., June, 1912.

* *Publications* of the Allegheny Observatory, Vol. 2, No. 11.

† *Astrophysical Journal*, **10**, p. 319; *id*, **35**, p. 286; *Lick Observatory Bulletin*, No. 201.

THE DRIVING CLOCK AND THE CLAMP AND SLOW-MOTION SCREWS OF AN EQUATORIAL.

WILLIAM F. RIGGE.

Providing an equatorial telescope with an efficient driving clock, and bringing the clamp and slow-motion screws on both axes down to the eyepiece, appear to be so exclusively the work of a professional mechanic, that probably not one of the readers of this magazine has ever attempted to construct these attachments, however much he may have felt their want in his own instrument. While the problem is really a very difficult one, it is by no means beyond the attainments of an amateur, who, together with a considerable amount of skill in the handling of tools, is possessed of an indomitable perseverance.

It is the purpose of this article to offer some suggestions on this matter.

As to the equatorial mounting itself, very little need be said. If the telescope was not provided with it originally when it was bought, it may possibly be still secured by tilting the common altazimuth form to the proper angle. At all events, an equatorial mounting, with or without circles, is not especially difficult or expensive to procure or construct. As it lies outside the province of this article, we shall take it for granted, and direct our attention to the clock and the slow-motions.

The wheel-work of the clock that is to drive a small telescope may be taken from an ordinary eight-day or even one-day clock. The main spring must be replaced by a weight, the cord of which is wound on a drum. For the sake of security the larger cogwheels may be doubled or tripled, two or three equal ones being lashed together.

The driving clock is generally attached to an equatorial through the medium of an endless screw and a wormwheel. It is evident that this contrivance must be very perfect in a large telescope. This consideration has probably prevented many an amateur from attempting its construction. It is, however, a very simple affair in a small telescope.

In designing this mechanism, we begin by selecting a tap which has the same thread and the same diameter that our endless screw is to have. We next procure the wormwheel, which may be an ordinary iron wheel of the desirable dimen-

sions. We turn a groove in its edge so that it may fit the endless screw. Centering this wheel so prepared upon the tool-rest of the lathe, we press it against the tap which is revolved in the chuck and supported by the tail stock.

We need not concern ourselves about the number of cogs or indentations that the tap will cut in the wormwheel, nor about our being able perfectly to close the circuit, so to speak, and make the tap fall exactly into its former cuttings after a complete revolution of the wheel. The latter difficulty seems to have no existence in practice, for the writer has threaded many a wheel in this happy-go-lucky style. The difficulty about the number of cogs is solved by the governor.

This governor is a kind of conical pendulum. It may be made to consist of two equal small weights (Fig. 1) attached to a vertical shaft by flexible supports such as a coiled cylindrical wire. This shaft is provided with two slotted arms extending in opposite directions and at right angles to it. Pins fastened to the bottom of the small weights slide freely

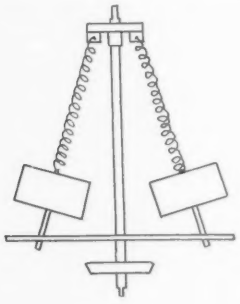


FIG. 1.

A SIMPLE CONICAL PENDULUM.

This simple conical pendulum or governor consists of two equal weights or balls suspended by coiled wire springs on opposite sides of on upright axis, around which they are forced to rotate by means of pins below them sliding in opposite slots. Two balls are necessary in order to keep the centre of gravity in the axis. The weight of the balls and the length of the coiled-wire springs must be determined by experiment.

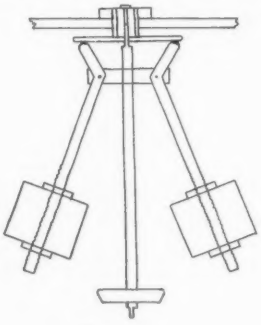


FIG. 2.

ANOTHER SIMPLE CONICAL PENDULUM.

This consists of two equal weights or balls fastened to rods on opposite sides of an upright axis. The upper ends of the rods are bent at an angle so that in rotating they press with more or less friction against an adjustable stationary disk. The position of the disk, the weight of the balls and the length of the rods must be found by experiment. The driving clock of the Creighton University equatorial has a governor of this description, except that the length of the rods is not adjustable.

PLATE XXIX.

THE 5-INCH EQUATORIAL OF THE CREIGHTON UNIVERSITY OBSERVATORY, 1885-1909.

The rods seen below the telescope belong to the declination system, the longer one being the clamp and the shorter the slow motion. The short rod with cross bar above the wormwheel on the polar axis is one of a pair which clamp the telescope in hour angle. The slow motion planetary gearing is on the north or left side of the clock box and not visible in the picture.

in these slots. When the shaft is rotated by the clockwork, the slotted arms by means of the pins carry the weights around in a circle. As the speed increases, the weights are driven outward by centrifugal force and move in greater circles. This reduces their speed of rotation so much so that a constant speed is very readily maintained. The exact dimensions of all parts of this simple conical pendulum must, of course, be obtained by experiment in order that it may have the proper rate of rotation, and give the wormwheel a speed of one complete turn in 24 sidereal hours. It was precisely in this fashion that the writer assisted in building a successful driving clock for a 3-inch equatorial many years ago, when he was pursuing his university studies at Woodstock College near Baltimore.

Fig. 2 shows another style of governor almost as easy to construct. The weights or balls are fastened to rods which are bent at an angle above their points of suspension. When the balls are thrown outward, the bent rods press against an adjustable stationary disk, and meet with such friction that their speed is rendered constant.

While he can therefore speak of personal experience in the construction and performance of a driving clock such as he has just described, the writer a short time ago saw a clock attached to a six-inch equatorial which presented two features essentially different from those just mentioned. The first was that the driving power was not a weight but a spring, and the second that it had a balance wheel and escapement like a watch. Such a contrivance would very much simplify the work for an amateur. The writer himself has used one for years, with ordinary spur gearing and without an endless screw, on a lecture-room heliostat, but was under the persuasion that the jerky motion of an escapement would unfit it for a telescope. However during the few minutes that he looked through the 6-inch, it seemed to perform very well.

Clamp and Slow-Motion Screws.

The application of clamp and slow-motion screws to both axes of an equatorial and controlling them from the eyepiece is a very difficult construction. Having been in a manner forced to undertake such a work by the cumbersome existing contrivance on his own telescope and the want of the requisite pecuniary means to have it done by a professional mechanic, the writer wishes to give to others who may be in similar circumstances the benefit of his experience. That skilled instru-

ment makers will find much to improve upon in the following account, is a fact accepted as a certainty in advance. They would help the cause by judicious criticism. They may, however, find one or other idea here presented worth perusal.

When the writer was placed in charge of the Creighton University Observatory at Omaha, Nebraska, in 1896, he found its 5-inch equatorial mounted exactly as shown in Plate XXIX with only two or three minor exceptions. The telescope was supported by a brass pier, and this by a truncated stone pyramid. The driving clock was set up to the west of the pier. In order to connect it to the telescope, after having found his star, the observer was obliged to leave the eyepiece and tighten two clamp screws, one of which is well visible in the picture, just above the wormwheel at the top of the polar axis. On the north side of the clock case, but not visible in the picture, was a planetary gearing with a grooved wheel, about which an endless cord passed loosely, and by means of two fixed eyelets might be kept in place when drawn taut by the observer in any position. Pulling this cord in one way or the reverse was supposed to give a slow motion in hour angle. It did do so to some extent in the beginning, when the chord was not drawn at too great an angle. Then the friction in the polar axis became habitually so great that the planetary gearing could not turn it at all, but kept on going idly round. It had to be permanently locked by placing a wooden wedge in the gearing. Thenceforth the only possible way to adjust the telescope in hour angle was to clamp it ahead of the star, to wait until the star came to the middle of the field, and then to start the clock by turning a thumb screw to the south of the clock box and releasing a detent in the wheelwork. That such a manner of procedure could meet with but unsatisfactory results and very quickly proved itself intolerable in practice, can be fully appreciated only by those whose instruments have similar defects.

Let me also direct attention to the rods and milled heads near the eyepiece of the telescope in Plate XXIX. The nearest is the clamp and the next the slow motion screw in declination. These rods always behaved well, but had to be attached, together with their supporting collar, by one of my predecessors. As the telescope left the maker's hands, the slow motion milled heads were two in number and placed some distance up the tube. One of the original two may be seen close to the electric lamp. The clamp wheel was near by. But both clamp and slow motion wheels were entirely beyond reach when one had his eye at the telescope.

Let me in passing mention another unpractical device. The declination circle consisted of two disks, one attached to the axis and the other to its sleeve. Strange to say, the movable one was graduated into degrees and halves, and the fixed one carried the vernier not on top or in its north point, but to one side, so that one could never know where to look for it. The two disks were later on exchanged, so that now the vernier is movable and always in the plane of the telescope.

The hour circle, however, was, next to the large lens, the best part of the equatorial and called for no improvement. It consists of three disks at the lower end of the polar axis. The upper one is fixed to the mounting and carries the sidereal time vernier at its very top. The lower one is attached to the polar axis and carries two diametrically opposite verniers. A milled head on this lower disk is made to turn the central one, which is provided with a double graduation, until one of its verniers reads the star's right ascension directly or increased or diminished by 12 hours. When the telescope is then revolved until the upper stationary vernier shows the sidereal time, and the declination vernier has been properly set, the star sought is in the field of view. As the declination circle is graduated to half degrees and the hour circle to two minutes of time, and as the field of view of the lowest power of the telescope is a degree and a half and that of the finder two degrees, the verniers, which read to single minutes of arc and 4 seconds of time are never used except by students who are learning to handle the instrument.

That an observatory telescope should have the awkward inconveniences mentioned before came about in this way. When the cabinet of physical apparatus of Creighton College was first begun in 1884, the telescope was amongst the outfit. It cost six hundred dollars. It was mounted on a stout oak tripod and housed in the new chemical laboratory in a room, to which access could be had only from the outside, in order to prevent the injurious action of the chemical fumes. At the time nobody had any idea of an observatory. As the telescope had been bought as a part of the physical cabinet, the defects pointed out above might easily have escaped detection, since in so many instruments of this kind graduated circles and other refinements serve a theoretical purpose only. Moreover as it was bought at a great distance, in London, the buyer could hardly suspect the presence of these defects. And lastly, as he

was a physicist, and no astronomer, he may be pardoned for overlooking or undervaluing them.

When my brother, Joseph Rigge, came to Omaha the year after, he was anxious to have the telescope set up permanently, since, aside from its inconvenience, rolling such a large instrument out upon the grounds every time it was to be used would go hard with it, and would keep its graduated circles and driving clock practically useless. A shed with a sliding or hinged roof would have satisfied him. Count John A. Creighton, our great benefactor and second founder, would not hear of this, but erected a brick round house with an iron dome. Hon. John A. McShane then provided the Howard mean time clock, the Fauth chronograph and electrical outfit. Ideas then began to expand. In the following year the transit room was built, and supplied by Count Creighton with a Fauth sidereal clock and a 3-inch Fauth transit, the latter having right ascension and declination micrometers and a circle that could be read to tenths of a second. A few years later the clock vault was built. The Class of 1904 presented a Steinheil grating spectroscope, G. Peters '08 a Zollner star spectroscope, and the Class of 1912 a Gaertner position micrometer.

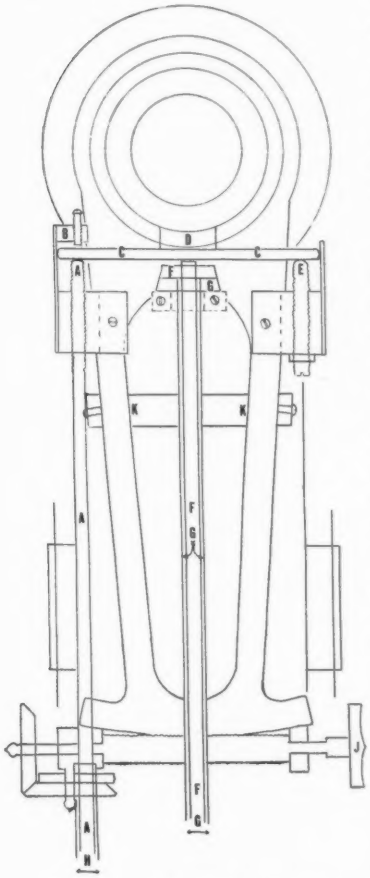
This condensed history of the Creighton University Observatory has been inserted here because it has never before been printed in POPULAR ASTRONOMY, and illustrates a peculiar, gradual and natural growth.

In August 1909 the cutting through of a street in front of the University made it necessary to lower the grade ten feet near the Observatory. A retaining wall of reinforced concrete was then begun about it. As it was foreseen that this would require several months and might be interrupted by the winter, during all of which time the Observatory would be inaccessible, a fine opportunity presented itself for constructing the much-needed improvements on the equatorial. The instrument was therefore completely dismounted and taken to the college shop. Much time and labor were spent upon it, and many a brilliant idea was wrecked in encountering the existing construction. However, the work was finished at last and proved to be a success. After its re-erection and the improvement of the interior of the observatory the instruments presented the appearance shown in Plate XXX.

In comparing this with Plate XXIX two changes will be apparent. The first is that the driving clock has been placed underneath the telescope between four small supporting columns, and the

THE 5-INCH EQUATORIAL OF THE CREIGHTON UNIVERSITY OBSERVATORY AFTER 1909.

The clamp and slow-motion rods and tubes of both axis are brought down to the eye-piece, the longer one forming the declination system. The tube of the telescope is cylindrical, and not conical as the picture may suggest.



second that the clamp and slow-motion screws on both axes have been brought down to the eyepiece, so that the observer may now make all the necessary adjustments without removing his eye from the telescope.

As the chief purpose of the present article is to explain this clamp and slow motion contrivance, another and larger view of it is presented in Plate XXXI and detailed drawings in Figs. 3, 4, 5. A study of Plates XXX and XXXI will show that there are two rods inside of two tubes, as is usually the case, the ends of all four being provided with milled heads or wheels. The rods operate the clamps and their wheels are nearest the eyepiece, while the tubes control the slow motions, the declination system being nearer the observer, as well for the sake of discrimination, as because it is the first to be used when the telescope is adjusted. As this original declination clamp and slow mo-

FIG. 3. THE DECLINATION CLAMP AND SLOW-MOTION SYSTEM.

The clamp rod A, whose play is limited by the stop block B, presses the short lever C against the plug D and thus forces it against the sleeve of the declination axis. The fulcrum of the short lever is the set screw E.

The declination clamp rod was driven from its former central and direct position by the right ascension clamp rod and bevel wheel F and its slow motion tube and bevel wheel G. H is the declination slow-motion tube which turns its screw through the medium of a spur and mitre gear. J is one of the original declination slow-motion wheels. K is a tie rod placed on the declination sector to eliminate lost motion, being made necessary by the position of the right ascension bevel wheels which cut away the best part of the sector. The range of the slow-motion is not endless, but limited, as is usual, the sector being in reality a part of a wormwheel.

tion performed well, it was changed only in so far as necessity demanded. Its rod and tube were displaced from their central position by the right ascension rod and tube, which had to operate a set of bevel wheels. The slow-motion side mitre wheel, which was formerly attached to the shorter of the two rods as shown in Plate XXIX is now turned by the tube and a spur gear.

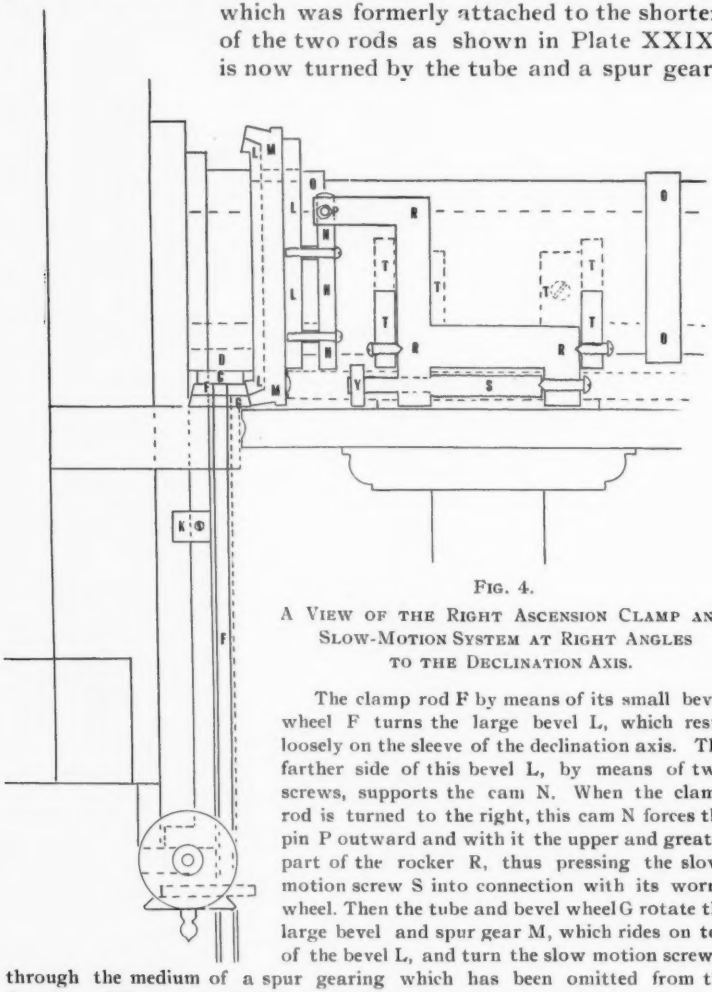


FIG. 4.

A VIEW OF THE RIGHT ASCENSION CLAMP AND SLOW-MOTION SYSTEM AT RIGHT ANGLES TO THE DECLINATION AXIS.

The clamp rod F by means of its small bevel wheel F turns the large bevel L, which rests loosely on the sleeve of the declination axis. The farther side of this bevel L, by means of two screws, supports the cam N. When the clamp rod is turned to the right, this cam N forces the pin P outward and with it the upper and greater part of the rocker R, thus pressing the slow-motion screw S into connection with its worm-wheel. Then the tube and bevel wheel G rotate the large bevel and spur gear M, which rides on top of the bevel L, and turn the slow motion screw S through the medium of a spur gearing which has been omitted from the drawing. TT are the brackets which support the rocker and are fastened to the sleeve of the declination axis. OO are ornamental rings on this sleeve, the left one serving to hold the clamp bevel wheel L.

The clamp rod inside of this tube continues to and screws through a rigid block of brass, on the further side of which it applies pressure to a short lever. The fulcrum of this lever is as far away on the other side of the right ascension rod and tube. It is an adjustable screw, and appears in Plate XXXI to be a sawed-off third rod.

The middle of the short lever just mentioned drives the old brass plug against the sleeve of the declination axis, and thus clamps the telescope as it did formerly. As the declination rod and tube are mounted rigidly in their bearings, the short lever must slide over the brass plug, when the slow motion screw is turned. The only inconvenience of this method is that the clamp wheel must be turned more than usual. It is however possible to tighten the clamp to such an exact amount that the telescope may be turned by hand into any position, at the same

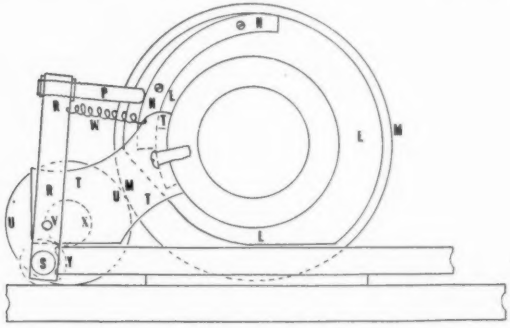


FIG. 5.

A VIEW OF THE RIGHT ASCENSION CLAMP AND SLOW MOTION SYSTEM IN THE DIRECTION OF THE DECLINATION AXIS.

The right ascension clamp rod forces the cam N under the pin P, which is held against it by the spring W, and moves the upper end of the rocker R outward, turning it about the pivot V and bringing its slow motion screw S into gearing with its wormwheel. T is one of the brackets that support the rocker. U is the larger and X a smaller spur gear on the same axis, U gearing into M and X into Y, which last is on the arbor of the slow motion screw S. X and Y are disconnected when the telescope is unclamped but like the screw S readily fall into position when the clamp is applied. Sometimes the screw slides into connection laterally and then the star in the field of view is thrown out of place, but a touch of the slow motion wheel, which must be used in any case, at once rectifies matters. When the clamp is loosened, the spring W draws the endless screw out of connection with its worm-wheel and leaves the telescope free in hour angle.

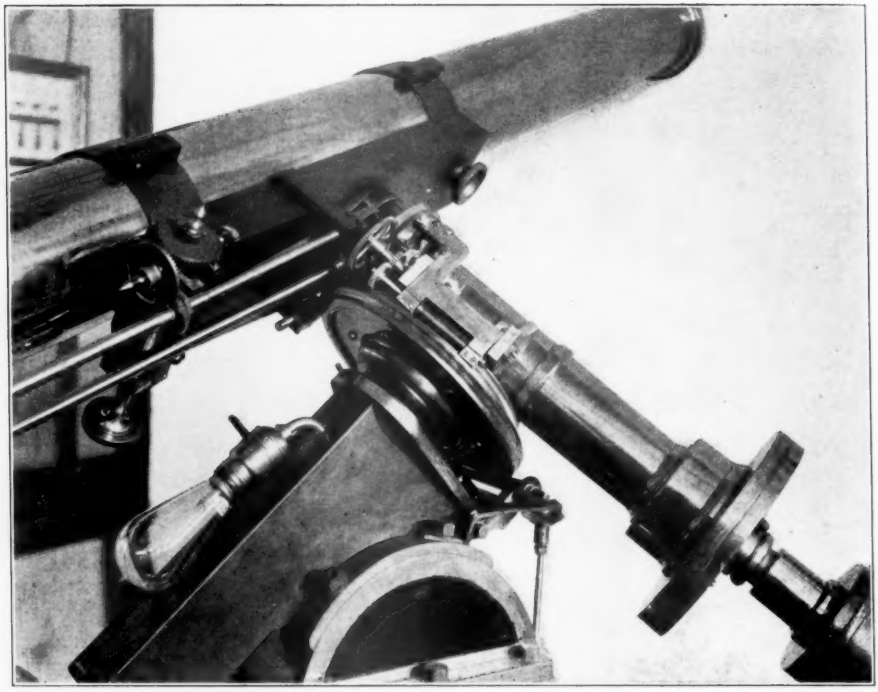
time that it will obey the slow motion. Experience soon placed a stop block to the range of the clamp screw, after the first short lever had been broken.

The right ascension clamp and slow motion presented many difficulties. It consists as is usual of two bevel wheels, one sliding over the other on the sleeve of the declination axis, operated by the right ascension rod and tube. Two brackets fastened to the sleeve of the declination axis above the wormwheel support a pivoted rocker. The lower end of this rocker carries an endless screw geared by spur wheels to the outer one of the two bevel wheels mentioned before. The upper end of the rocker carries a pin, and is drawn by a spring against the inner bevel wheel so as to throw the endless screw out of connection with its wormwheel. When the clamp wheel is turned at the eyepiece, its rod, by means of a small bevel wheel, turns the large inner bevel wheel on the declination axis. The latter then pushes a cam or curved inclined plane under the pin of the rocker and presses the endless screw against its wormwheel. Then the slow motion wheel at the eye-piece, by means of the other bevel wheel and the spur gears, turns this endless screw and slowly moves the telescope in right ascension.

There are therefore two wormwheels on the polar axis, both free from this axis but firmly bolted together. The lower one is turned by the driving clock, and the telescope is turned about the upper one by the right ascension slow motion gearing. This slow motion is endless, as it was designed at a time when the clock was very unreliable. The latter received its share of attention later on and now performs very well. It is evident that the right ascension slow motion screw does not in the least affect the running of the clock. The spur gearing reduces the motion of this screw in the ratio of 1 to 3, in order to make the wheels of both systems equal at the eyepiece, since the right ascension wormwheel has one-third the diameter of the declination sector. The right ascension slow-motion wormwheel was made in the happy-go-lucky way mentioned before near the beginning of this article, since the number of its cogs is of no consequence.

The novel features of the clamp and slow motion system described in this paper seem to be these: that the right ascension slow motion is endless, that its endless screw is thrown in and out of gear, and that the declination clamp is the usual plug operated by a lever. While, as is generally the case when an amateur attempts a difficult job, there seems to be no end of

PLATE XXXI.



A Nearer View of the Clamp and Slow-Motion Systems.

The upper rod and tube, together with its spur and mitre gear and lower milled head, operate the declination system. The fulcrum screw of the short lever may be plainly seen, but the stop block for the clamp screw has not yet been attached. The upper end of the short lever may be glimpsed. The lower rod and tube, which belong to the right ascension system, end in bevel gearings. The two wormwheels are free on the polar axis but bolted together, the lower is driven by the clock, and the telescope is turned about the upper one by the endless screw and the spur bevel gearing. This endless screw is carried by a rocker which is supported by brackets attached to the sleeve of the declination axis. The pin at the left upper end of the rocker is forced outward by the right ascension clamp and cam, and presses the endless screw into its wormwheel. The right ascension slow-motion is endless.

practical difficulties and balkings, the work has proved a success. The expense was confined to material, to iron and brass castings, and to the cutting of the cogs on the bevel wheels by an expert machinist. It amounted to about twenty dollars, about one-tenth of what an astronomical instrument maker estimated. Want of funds is the usual affliction of professors of science, and blocks the way to the realization of many a pet idea, but when one can acquire the necessary skill, can obtain gradually at least a tithe of the capital, and can find or make the necessary time, one can generally help himself, and then the realization of the idea is all the more enjoyable because it is the fruit of personal labor.

Creighton University, Observatory,
Omaha, Nebr.

ROSA URSINA, sive SOL, A Retrospect.

H. D. CURTIS.

In these days of mountain observatories devoted solely to the study of our sun, of great tower telescopes, of spectrographs of tremendous power set in deep wells in the solid rock, bolometers with their delicate blackened ribbons and rock-salt prisms; these days when we not only let the light itself record the face of the sun, but choose even that particular wave-length of light with which we desire to do the work; this epoch where the minutest specialization combined with almost unlimited instrumental equipment is daily acquiring new facts, it is something of a relaxation to turn back for a moment's respite to the days when our scientific world was "new and all." When CHRISTOPHER SCHEINER, the painstaking Jesuit, made his observations of sunspots in the years 1611-1625, gathering material for the large tome to appear a little later under the title, *Rosa Ursina, sive Sol*, the field of observation lying before him was a practically untrodden one; his must have been the keen joy of the discoverer, the pioneer who realizes his priority in an untouched realm.

The year 1910 marked the three-hundredth anniversary of the discovery of sun-spots; the question of priority of discovery is a difficult one to settle, and it is not unlikely that the dis-

covery was made independently and nearly simultaneously by four astronomers, though the credit of discovery is usually ascribed to GALILEO. The first published account is that of FABRICIUS, who published at Wittenberg in 1611 a pamphlet under the title *De Maculis in sole observatis et apparente eorum cum Sole conversione narratio.* GALILEO's work on sun-spots was published in 1613, and the first observation there recorded was for June 2, 1612, but it seems evident from his letters that the actual discovery was made about November, 1610. SCHEINER, while professor of mathematics at Ingelstadt, first saw the sun-spots in March 1611, and was urged to publish the fact, but as these matters appeared to his superior in the order to be contrary to the principles of the philosophy of that day, it was deemed advisable to publish under an assumed name, *Appeles post tabulam*, which was done in January, 1612. These letters were sent to GALILEO in January, 1612, and GALILEO refuted SCHEINER's first idea that these objects might be small planets near the sun, a theory which SCHEINER himself abandoned almost immediately. England's claims to the discovery are, however, fully as strong as those of Germany or Italy, for ZACH found in the manuscript notes left by the English astronomer HARRIOT* an unbroken series of telescopic observations of sun-spots extending from December 8, 1610 to January 18, 1613, made with telescopes of magnifying powers 10, 20, and 30, showing that HANS LIPPERSHEY's invention of the telescope about 1609 was already being put to use. HARRIOT appears to have been an unusually able and versatile man, and America can claim some interest in his work, for he went to Virginia in 1584 with Sir WALTER RALEIGH and took part in the surveying of the lands of the first colony there, publishing in 1588 a work entitled, "A brief and true Report of the new-foundland of Virginia, of the Commodities there to be found and raiſed." Whoever may have been first to discover sun-spots, however, to SCHEINER belongs the undoubted credit of having made the first thoroughgoing and exhaustive study of the subject.

First of all, why the title *Rosa Ursina, sive Sol* (*The Ursine Rose, or the Sun*?) Perhaps no more striking example of fulsome flattery is to be found in the annals of literature than this same title, a metaphor so astounding in its scope that it fairly takes one's breath away to realize that this dedication comes

* *Astronomisches Jahrbuch*, 1788, p. 154.

from a man of fifty-five, a scientist of great eminence in his day, whose observations recorded in good "monkish" Latin stamp him as a very careful observer and a logical, though painfully prolix reasoner. For the volume is dedicated to PAULUS IORDANUS II URSINUS, Duke of Bracciano, the head of the wealthy and powerful Orsini, a family which had furnished a Pope and many a bishop and cardinal to the ranks of the church. The emblem of the Orsini family was the rose, and on the back of the title page we see the portrait of the noble patron who doubtless financed the work, surrounded by a wreath made up of alternate roses and drawings of the sun girdled with sun-spots. Beneath is the verse:

URSINAE Dux Gentis Aue; Tibi plaudit Olympus;
Currit in obsequium Phoebus & Ursa tuum.
Signa genusq. suum mutis incidere saxis
Si potuere alii, Fors ea magna fuit.
SIGNA Genusq. tuum Caelestibus indita fulgent
Orbibus; URSINOS fixit in axe Deus.
Macte animi virtute Heros, genus Alte. Trophaeis
Quod nimis arcta tuis est humus astra petis.
MOECENATI Auctor.

Translated (perhaps too freely),—"Hail, Chief of the URSINE Race! Olympus applauds Thee; Phoebus and thy Bear run to serve Thee. If others have carved their name and fame on the silent rocks, 'twas Fate had aided them. But thy EMBLEM and race shine fixed in the celestial realms; God fixed the URSINE orbs in place. Well done, Hero, of noble race. Earth too narrow for thy triumphs, thou seek'st the stars. The Author, —to his MAECENAS." The capitalization apparently relegates the Deity to a somewhat subordinate position. Turning back to the title page we see the sun throwing its image through an aperture upon a screen; the sun is depicted as half sun, half rose; in other words, the orb of day is re-named the Ursine Rose! I do not know how we can appreciate this metaphor in this day and time, except by trying to imagine that a HALE or an ABBOT had entitled a solar treatise, "The Carnegian Thistle, or the Sun." We must remember, however, that GALILEO called the satellites of Jupiter *sidera Medicea*, "The Medicean stars", and that, two centuries later, Uranus would have been called *Georgium sidus* if HERSCHEL had had his way.

One advantage, and only one did SCHEINER have over the scientists of today; the science of 1600 had the convenience of

a universal language; GAUSS and BESSEL still used Latin for some of their published work, but a scientific article in Latin today is so unusual as to arouse interest. Today we should be able to read at least three languages, and better four or five, nor does the adoption of a Volapuk, Esperanto, or Ido to relieve this difficulty seem very probable in the immediate future. One wonders today whether the use of Latin by these scientific patriarchs was really as free and easy as their works seem to indicate, or whether the process was not like the words of Dominus Hyacinthus de Archangelis in BROWNING's Ring and the Book,—

> ".....stick in this and throw out that,
> And, having first ecclesiasticized,
> Regularize the whole, next emphasize,
> Then latinize, and lastly Cicero-ize."

It is not easy to get at the matter of value in this great quarto of nearly eight hundred pages. There are pages of polemics and arguments as to priority, pages and pages of quotations from the Church Fathers (a strong argument of that day) as to whether the sun is solid or liquid and other similar questions. Even the statement of facts and demonstrations of value are so bolstered with lemma after lemma and conclusion after conclusion, through secondly and thirdly, occasionally up to thirty-secondly, in painfully prosy and prolix fashion that the dead language in which it is written becomes the least of one's troubles. Perhaps nothing impresses one more strongly with the fact that this work is at the beginning of things than to note the calculations, where the products of trigonometrical functions are multiplied out, for that wonderful labor-saver, the logarithm, was not yet in use.

Certain points stand out clearly, however. In this work sunspots were for the first time subjected to careful study, the laws of their motion derived, their general inclination to the ecliptic, their motion with the sun, their growth and decay. Nor was any very material increase of the world's knowledge of these appearances made for nearly two centuries after SCHEINER's time. It was a pioneer work and long remained a standard. Moreover, the first telescopes of LIPPERSHEY were composed of a convex and a concave lens; while KEPLER explained the theory and gave some of the advantages of a telescope composed of two convex lenses in 1611, to SCHEINER belongs the credit of having first actually constructed a teles-

cope of this form. In some at least of SCHEINER's instruments the lenses were made from *colored* glass instead of transparent, to diminish the brilliancy of the sun, and he gave this the name "helioscope" to distinguish it from the ordinary *tubum opticum* with transparent lenses. "I made such a tube at the start," writes SCHEINER, "from pieces of blue glass plates. .....But the manufacture of such a helioscope requires great industry, labor, patience, skill, and not a little expense, difficulties which will keep many from the study of this phenomenon,

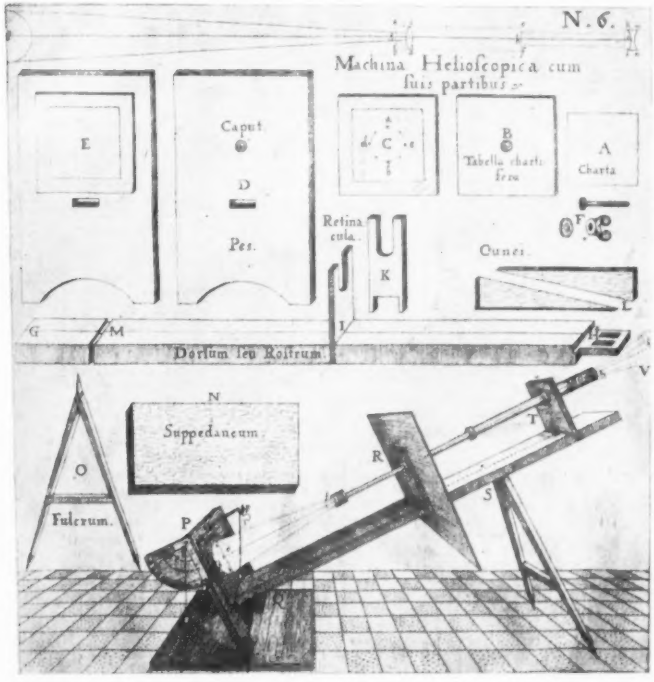


FIGURE I. SCHEINER'S HELIOSCOPE.

because they do not provide themselves with a similar instrument. This difficulty is obviated if you buy an ordinary tube, or Telescope of good quality, such as are sold everywhere at a moderate price, and by interposing plane pieces of colored glass temper the effect of the transparent lenses as may be necessary."

SCHEINER's methods of observing, and more particularly the instruments he used may be of more than passing interest to the present day reader. Figure I gives a view of his "helioscope"

as set up for use, and its construction and manipulation are too obvious to require any extended comment. The solar image was projected upon a sheet of paper, just as is done by many visual observers of sun-spots today, and a plumb line, seen at *p*, gave the proper means of orienting the image and deriving data

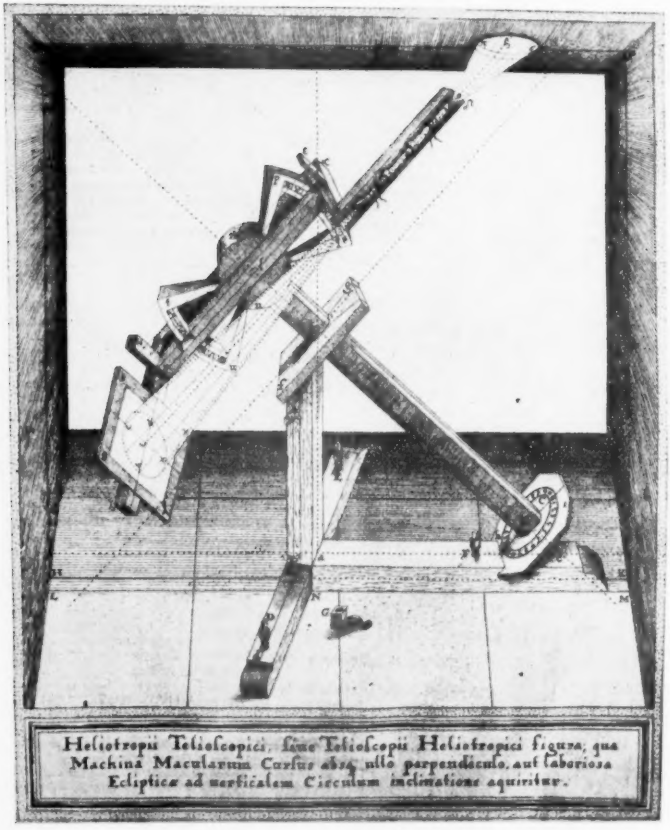

Heliotropii Telioscopici, sive Telioscopii Heliotropici figura, qua
Machina Macularum Cursus absq; ullo perpendiculo, aut laboriosa
Ecliptica ad verticalem Circulum inclinatione aquiritur.

FIGURE II. THE FIRST EQUATORIAL TELESCOPE.

as to the path of the spots from day to day. A graduated arc at *P* afforded means for setting the instrument to the proper altitude; in actual use the position of the instrument in altitude and azimuth had to be changed every few minutes, and we marvel at the amount of material which SCHEINER derived with such a clumsy and troublesome instrument.

Of still greater interest is the drawing and description of the first equatorial telescope, the invention of which is wrongly credited to SCHEINER in HOUZEAU'S *Vade-mecum*. SCHEINER himself gives the credit for its invention to Father CHRISTOPHER GRUENBERGER. Clumsy as it appears to us in comparison with an equatorial of the present day, it possesses all the essential parts. The polar axis, *bK*, is of wood and is provided with an hour circle graduated to hours at *C* (Fig. II). The declination axis is formed by the pivot at *l*, and the sections of the declination circle, *pqtu*, larger and heavier than the little telescope, are graduated with the signs of the Zodiac instead of in degrees. The little holes at ϵ and *H* served as a "finder." In principle, it differs from the 36-inch refractor only in the fact that it has no clock, and from the construction of the declination arcs it was impossible to reach all declinations, a fault which GRUENBERGER says he would remedy were he to build it a second time.

When we look at SCHEINER'S drawings of sun-spots and the methods of analysis which he employed in their study, we do not realize that there has been a gap of three centuries between his day and ours, for practically the same methods were used in the last century, before the advent of photography so changed all our methods of attack. But one feels, here and there, in turning over the pages of this fine old sheepskin-bound quarto, that far more than three hundred years intervenes between the scientific view-point of 1610 and 1910. Perhaps nothing can make this so clear as a few extracts from a letter which closes the book, written by Cardinal BELLARMINE (the same with whom GALILEO was involved). The letter is addressed to Prince FEDRICUS CAESIUS who had written a learned treatise on the "liquid" constitution of the heavens.

"I have read with great pleasure the work sent me by your Highness, for it is truly very learned, both new and entirely in accord with that opinion *which I hold to be true*. Only one thing is not entirely to my liking, in that Your Highness denies that the figure of the heavens is round, on the support of Saint Chrysostom and others. I hold the Scriptures oppose this in Ecclesiasticus c. 24 where it says *Gyrum coeli circuivi sola*. And we see the Sun, Moon, and Stars circle about the globe of the Earth. And Solomon in Ecclesiastes says *Sol gyrans per meridiem &c.* Moreover there is no doubt that the circular figure is the more perfect, and we know that the works of God are perfect.....[The cardinal then goes on to state that, when a young man, he had tried to think out a scheme which

would explain the motions of the stars and at the same time explain the motions of the planets, but had failed to find a satisfactory theory].....These and similar matters I have wished to learn from Your Highness, if perchance this [theory] has furnished suitable arguments for the explanation of the movements of the stars in such a manner that the *opinion of the Holy Fathers requiring an immovable heaven and movable stars* could likewise be preserved.

Rome, August 25, 1628;

Your Highness's Obedient Servant,

Card. BELLARMINUS."

The italics are as given in the original. It is a mistake to regard this point of view as the peculiar characteristic of any particular creed or sect of that day; rather was it the attitude of the age, and few and far between were the minds keen enough to perceive, and brave enough to insist, that the study of the observed fact must come first, with time-honored theories a weightless second.

USE OF THE FIELD GLASS IN OBSERVING VARIABLE STARS.

H. W. VROOMAN.

In the observation of variable stars it frequently happens that some of the brighter comparison stars are not in the field with the variable. In cases of this kind a satisfactory record is difficult, if not impossible, to get.

The writer's desire is to place before his friend and companion in labor, the amateur, a plan which he has adopted with success. It is to abandon the telescope and use the field glass, giving a field of possibly 5°. When the rise of the variable drives one out of the field for comparison stars, and the field or opera glass is substituted for the telescope, the observer is apparently in an unknown country because of the larger field it gives. The field is entirely new; nothing is recognized; in vain is a familiar combination of stars looked for. That beautiful, clear picture that heretofore has made it so easy to locate the variable cannot be found. The field is as different as though the glass were turned into another zone. Almost all of the stars that have been seen and have become so familiar are beyond

the power of the field glass, and a large number of brighter ones, hitherto visible with the telescope only as they came to the eye as the instrument swept the sky, now stand out in the field, a new combination to study and chart.

Which one is the variable, which are the comparison stars?

Here are two methods easily worked. One requiring the Bonner Durchmusterung and the other a good star atlas, preferably the one that charts the most stars. Schurig's Himmels-Atlas is good.

If the BD is to be used in preparing the chart, find the position of the variable for 1855 (the BD positions are for that year). Let the chart cover 10° of declination and the same distance in right ascension, with the variable in the center.

Remember that the nearer the pole the closer the hour circles are to each other, and as the dimensions of the chart should be the same in both directions a given length of abscissas of this graph will contain more hours, minutes and seconds of right

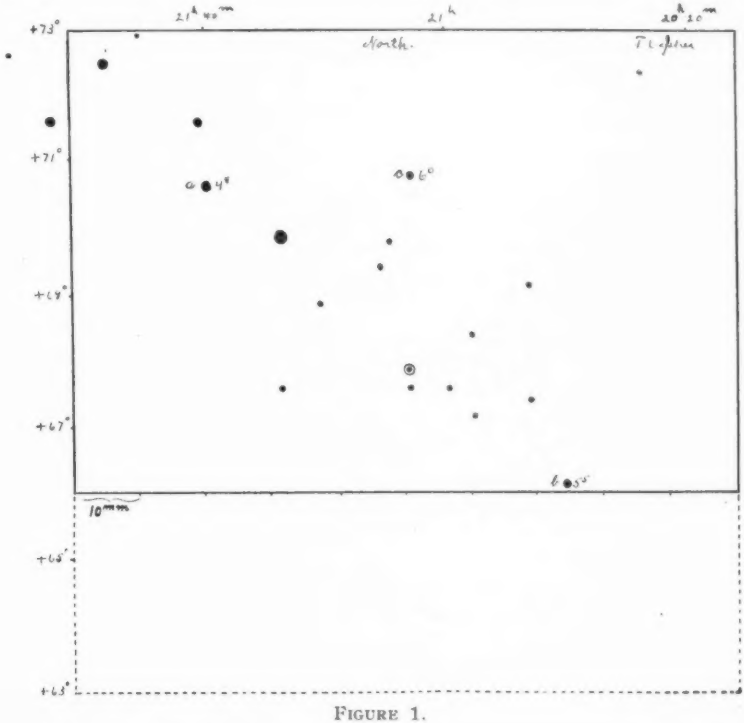


FIGURE 1.

ascension the nearer it is to the pole. This will be made clear by referring to Fig. 1. (T Cephei's position for 1855: R.A. $21^h\ 7^m\ 37^s$ Dec. $+ 67°\ 54'.0$). 1° of declination = 10mm; the same scale in abscissas contains 11 minutes of right ascension. If RU Virginis were the star to be charted, with a declination of $+ 4°\ 56'.5$ (1855) the length of a degree of declination would be the same as for T Cephei but 10° along the axis of abscissas would contain but 40^m of right ascension against T Cephei's $1^h\ 50^m$. Of course, when the hour circles of this chart are drawn parallel instead of converging as they should, the stars will not have their exact relative positions, but it will not matter for the purpose in hand.

FIGURE 2.

Should the reader be fortunate enough to possess the charts accompanying the BD catalogue the work would be greatly facilitated, but where the catalogue alone is at hand it is no great hardship to chart the stars. Simply write the right ascension scale at the top and attach the sheet to a drafting board or table. Paste a sheet of paper, marked for the degrees of declination, to a T square, push the square to the right or left until it touches the right point in right ascension, and plot the star at the proper declination. The T square may be dispensed with by using coördinate paper, but the former method is much more desirable. Chart all the stars brighter than magnitude 7.5 and there will be plenty of stars with which to identify the comparison stars. In many instances it will be found unnecessary to chart the entire 10° declination. Notice that in Figure 1 no stars are plotted south of +66°, nor was it necessary to plot all the stars brighter than magnitude 7.5, as the variation in magnitudes was so great that identification was easy with the use of just a few. Where the field is made up of stars of almost even magnitudes a greater number are often required.

Now that the stars are all plotted it remains to mark the variable and comparison stars. In order to do this it is necessary to have the BD number or the position for 1855, when it will be very easy to locate them with the T square. Vols. 37 and 57 of Harvard Annals contain the information

required for many variable stars, including their positions for 1900. These may be had for a nominal price from Harvard College Observatory. If the Annals are not available, coördinates for all comparison stars desired may be had from Professor Edward C. Pickering. If the chart is plotted from positions for 1855 the positions for 1900 will have to be reduced to 1855 before insertions can be made. The 1903 edition of the BD gives the annual precession of the stars, which, the writer believes, is not true of the earlier edition. For this reason alone the purchaser should be careful about which edition he buys.

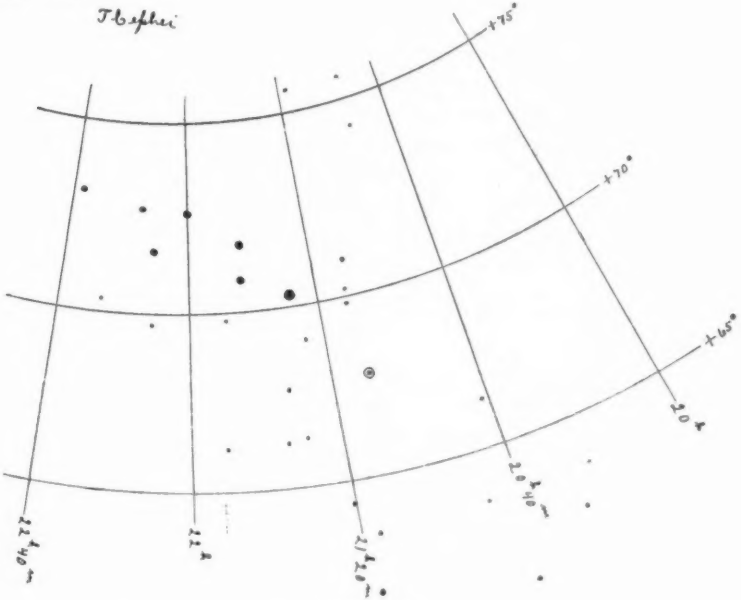


FIGURE 3.

The next thing in order is to locate the field. Procure some work on the constellations and, in the constellation which includes the desired field, select one or two prominent naked-eye stars which are prominent in forming the figure of the constellation, and note the position of the variable field with relation to them. Any star atlas will give approximate coördinates for these guide stars and from these approximate positions the exact positions can be traced in the BD. Fig. 2 will serve as an illustration. This is the constellation Cephus and β was selected for the guide star. This star happens to be

well within the variable field and is marked in Fig. 1. William Tyler Olcott's book, "A Field Book of the Stars," is the best work for constellation study the writer has seen.

Figure 3 is a tracing from Schurig's Himmels-Atlas, enlarged, for the same variable, T Cephei. Using this atlas instead of the BD has two advantages over the other method. The chart is much more quickly made and the hour circles have the right positions. However, unless the chart is enlarged three or four times the field will not be easily recognized and in some instances cannot be. A pantograph, which may be had for $1.00, makes the process of enlarging easy. The serious drawback to this method of charting is in fields where the positions of the stars are such as to cause doubt about which is the comparison star or variable. In this emergency the insertion of a few BD stars not shown in the atlas is necessary. If Schurig's atlas is used many variables will be found already charted. If they are not on the map the positions of the variable and the comparison stars will have to be corrected for precession to 1925 before insertion.

Kokomo, Ind.

ECLIPSING BINARIES.*

HARLOW SHAPLEY.

I. Introduction.

The distinctions formerly made between variable stars of the type of Algol and of the type of Beta Lyræ have so completely vanished with the increased refinement of the photometric work of recent years that it is no longer possible to use consistently the old classification. Previously a constant maximum phase in the light curve differentiated Algols from the continuously changing stars of the Beta Lyræ class. But since Stebbins has shown that Algol itself is a Beta Lyræ variable (maximum light not constant and a secondary dip),† and the detection of secondary minima and of ellipticity and radiation effects in the maximum light of Algol variables proves to be only a matter of accurate observations, it seems appropriate to aban-

* Adapted from a paper read at the Pittsburg meeting of the Astronomical and Astrophysical Society of America, August 28, 1912.

† *Astrophysical Journal*, **32**, 185.

don entirely the former classification and to group under the head of eclipsing variables all the stars whose principal light changes can be accounted for by the theory of eclipse. This group also contains a few stars that are ordinarily included in the lists of short period variables but whose light changes can be interpreted as eclipse phenomena.*

Up to the present time about 150 eclipsing stars have been discovered, of which 110 have known periods of light variation.† A great number of these are of recent discovery, relatively; and for them there exists as yet little or no information concerning the shape of the light curves. For many of the older members of the class, however, sufficient observational data have been collected by different observers to make theoretical investigations of the orbits possible. The variable star observations secured at the Harvard College Observatory during the last 30 years are in number and excellence the most important material for discussions of the orbital elements. Light curves determined by observers using the Argelander method are of value for orbital computation when the adopted magnitude scale can be verified or corrected through photometric measures of the comparison stars. Although 20 or 25 good light curves have been derived from the photometric measures, until recently few attempts had been made to solve for the elements of the eclipsing binary systems.

II. The Study of Eclipsing Binaries at Princeton.

The difficulties in the way of the ready solution for the elements of eclipsing stars have been practically removed by the recent theoretical work of Professor Russell on this subject. The series of papers in the *Astrophysical Journal*, beginning with the June number of this year, has provided the theoretical basis for an extended investigation of the orbits of this class of double stars. The study has included a discussion of all the good available data, and to the observations made and published elsewhere I have added several hundred of my own made during the last year on a dozen different eclipsing

* Such stars are: A) W Ursae Majoris, W Crucis, RR Centauri, SZ Centauri, RZ Muscae = RZ Centauri. *Harvard Annals*, **56**, No. 6, Table 8.

B) TT Aurigae, W Ursae Majoris, RS Scuti, U Pegasi, V Puppis, X Carinae, RR Centauri. *Vierteljahrsschrift der Astronomische Gesellschaft*, **46**, 282-285, 1911.

† *Harvard Annals*, **56**, No. 6, Tables 6 and 7.

variables. A total of nearly 50 orbits have been computed, and from this accumulated material a number of interesting properties of eclipsing stars as a class may be observed.

From the light curve of an eclipsing variable we are able to determine the radii of the two stars in terms of the distance separating them, the inclination of the orbit to the line of sight, the light of each star and their relative surface brightness, the mean density of the system in terms of the Sun's density, the elongation of the stars toward each other due to their mutual attraction, the radiation effect of one star upon the other, the eccentricity of the orbit, and the longitude of periastron. But in very few cases have we sufficiently accurate data to determine all of these quantities. The orbits are so nearly circular that in most cases the eccentricity and the longitude of periastron can not be computed. For many stars the ellipticity of figure is so small that the existing observations do not show it, and in like manner the radiation effect is generally negligibly small. For the few bright eclipsing variables for which spectroscopic orbits of both components have been obtained, the actual linear dimensions of the systems are readily found.

III. Relative Dimensions of the Component Stars.

There is a considerable variation in the relative sizes of the two members of an eclipsing pair. Among those whose light curves exhibit a long interval of constant minimum light at primary eclipse are found certain systems in which the dark companion is ten times the volume of the brighter, and has scarcely a tenth of the total light. Such a star is the well-known S Cancri; another is RR Draconis. Some systems are composed of stars very nearly alike in all respects, as Beta Aurigae and U Ophiuchi, while others are alike in size but different in brightness as U Pegasi and SV Centauri. An interesting condition with regard to the relative sizes of the stars is that the dark companions are larger than the primary components in the majority of cases; and in those instances where the dark star is inferior in size, the disparity is always small. The eclipse of a large bright star by a dark one of much less than one-half its radius would, of course, ordinarily escape detection.

The inclinations of the orbits to the line of sight are necessarily rather small in the average case. For some partial eclipses however, the angle is greater than 30°. The inclination of the orbit, the radii of the stars, and the surface brightnesses

are all considerably changed if we assume that the stars are darkened toward the limb rather than uniformly bright over the entire apparent surface. We have recently considered the theory of darkening at the limb,* and although its amount or even its actual existence for eclipsing stars is not conclusively demonstrated, the evidence is much in favor of a darkening toward the limb of a considerable degree—perhaps even greater than for the Sun. In Figure 1 are two diagrams of the system of S Cancri as seen from the earth—the upper one representing the system on the hypothesis of uniform distribution of the star's light over its apparent surface, and the lower representing the system when we assume the stellar disks darkened to zero at the edge. The light curve of principal minimum is represented but slightly better on the latter hypothesis. The certain detec-

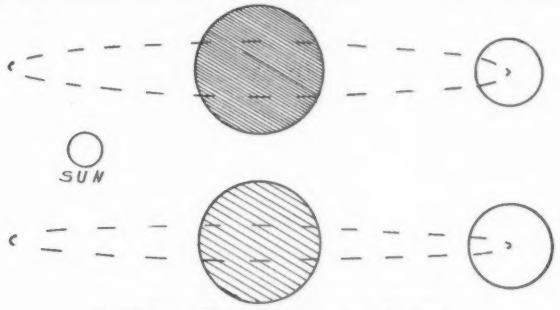


FIGURE 1. THE SYSTEM OF S CANCRI.

The diagrams show the orbit of the bright star (as viewed from the earth) relative to its large faint companion. The surface of the bright component is assumed uniformly bright in the upper diagram, and completely darkened at the edge in the lower. Notwithstanding the difference in volume, the small bright star may be the more massive, as is the general rule with spectroscopic binaries. The Sun is compared to S Cancri on the assumption that each component has a mass equal to that of the Sun. For uniformly illuminated disks, the light intensity of the small star is 44 times that of the larger; for "darkened" disks it is only 22 times as bright per unit area.

tion of darkening must be obtained in other ways. It is seen from the diagrams that the inclination to the line of sight is less for the "darkened" system, and that the stars approach each other in size. The latter change also means that the stars will be less unequal in surface brightness, for the light of the smaller bright star is spread over a greater area, while that of the large faint one is restricted to a smaller surface.

* H. N. Russell and H. Shapley, *On Darkening at the Limb in Eclipsing Variables, Astrophysical Journal*, **36**, October, 1912.

In Figure 2 are similar diagrams of W Delphini. The "uniform" elements of this star have been recently computed and published by Professor Russell.* Other eclipsing binaries are represented in Figure 3.

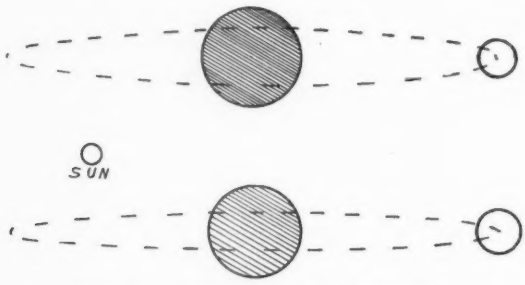


FIGURE 2. THE SYSTEM OF W DELPHINI.

The relative orbits of the bright body are shown—the upper diagram assuming uniform brightness, the lower assuming stars darkened to zero at the edge. When the small body is eclipsed, the light falls off 2.7 magnitudes in less than seven hours. A complete revolution is accomplished in 4.8 days.

IV. PROBABLE FORM OF THE COMPONENTS OF AN ECLIPSING BINARY.

When the two stars of an eclipsing system are relatively near together the gravitational pull tends to elongate both of them in the direction of the line of centers. The researches of Darwin on rotating fluids indicate that such stars are very nearly perfect ellipsoids. The longest axis is of course in the line of centers, and the shortest one, which is the individual star's pole of rotation, is perpendicular to the plane of the orbit. The components of such a system of ellipsoids rotate in the period of revolution, as the Moon and Mercury do. If their distortion is considerable the light received from the system will vary with the position of the bodies in the orbit (independent of the light changes due to eclipse), for at different times different surface areas will be turned toward the earth. The light changes outside of eclipse give rise to the curved maxima of the light curves of many eclipsing stars, best known in the extreme example of Beta Lyrae. In the systems whose components are so widely separated that the gravitational distor-

* *Astrophysical Journal*, **36**, 138.

tion is hardly perceptible the individual stars are probably spheroids flattened at the poles. In Figure 4 are diagrams of an ellipsoidal star.

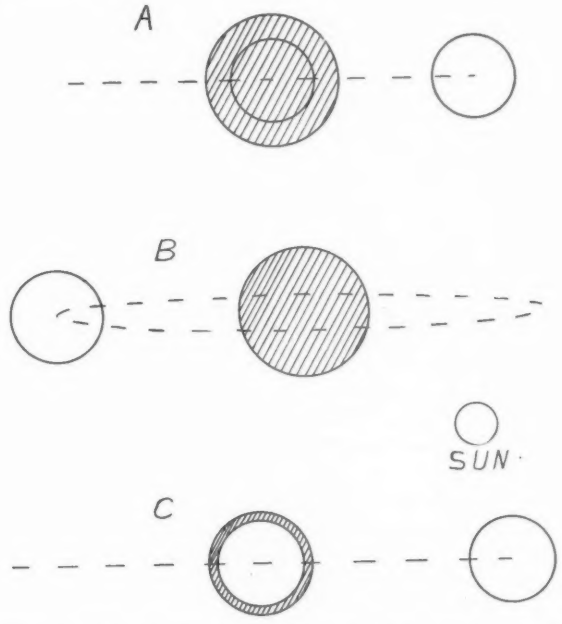


FIGURE 3. THREE SYSTEMS THAT TOTALLY ECLIPSE (UNIFORM DISKS).

A) U Cephei: The plane of the orbit passes through the earth; that is, the eclipse is central. The diagram shows the system at greatest elongation, and at the middle of principal minimum. There is a secondary minimum of less than one tenth of a magnitude.

B) WW Cygni: The plane of the orbit is inclined about four degrees to the line of sight. The bright star is not quite one tenth as dense as the Sun, if their masses are equal, but is three times as dense as its dark companion.

C) UW Cygni: The appearance of the star at greatest elongation and at secondary eclipse. We are in the plane of the orbit. The range at principal minimum is 2.6 magnitudes; the secondary minimum has not been observed, though computation indicates that it is deep enough to be measured.

V. THE LOW DENSITY OF ECLIPSING STARS.

If we make the reasonable assumption that the average eclipsing system has double the mass of the Sun, then we can draw the Sun to scale in all diagrams of stellar systems and its size, compared to that of the individual components, indicates

immediately the relative densities of Sun and star. The larger volume (hence smaller density), which is evident in the diagrams above, is typical of this class of stars. The eclipsing variables are mostly of spectral classes B and A. There are a few stars, however, of the later spectral types. We are thus enabled to make a striking comparison of spectra with the densities, for the average density of the brighter component (the spectrum of the dark companion is rarely seen) gives a fair idea of the density of the average star of each spectral class. The A-type stars are about one fourteenth as dense as the Sun (if we assume

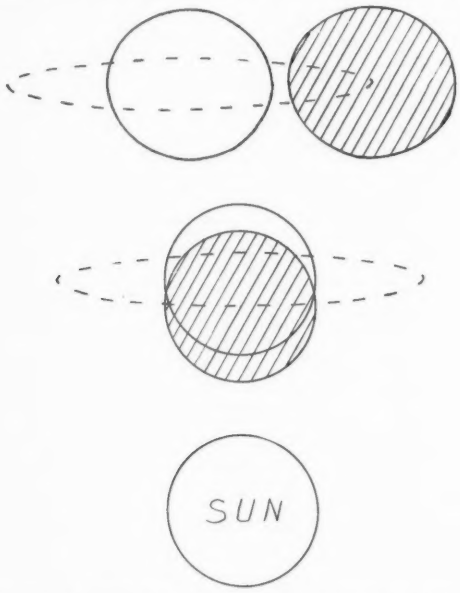


FIGURE 4. THE SYSTEM OF U PEGASI (UNIFORM DISKS).

The upper diagram shows the components at greatest elongation as viewed from the earth. The light is then at a maximum for we see the ellipsoidal stars with their greatest apparent area. One fourth of a period later the system appears as in the lower diagram, and we have the brighter star partially eclipsed at principal minimum. There is a minimum at this point independent of the eclipse, for the stars are now viewed endwise. The spectrum is thought to be of type F. The density of the system is three fourths that of the Sun—relatively large for an eclipsing binary, but not remarkable for a star with an F-type spectrum. The light curve resembles that of Beta Lyrae. One component is 50% brighter than the other, hence the alternate minima are unequal in depth. The period is nine hours—one of the shortest known. It is possible to have six eclipses in one day.

the disks darkened to zero at the edge); the B-type stars one eleventh; the F-type stars about one third; and for the two eclipsing stars of class G for which orbits are known, W Ursae Majoris exceeds the solar density by nearly 100 per cent, while W Crucis is approximately one hundred thousandth as dense.

Princeton University Observatory,
October 3, 1912.

GALE'S COMET *a* 1912.

E. E. BARNARD.

After a remarkably prolonged shortage of new comets, the present one was discovered on September 8 by Mr. Walter Gale at Sidney, N. S. W. At first the comet was too far south (δ—37°), and too near the sun, to be seen from the northern hemisphere, but the rapid northeast motion finally brought it above our southwest horizon. The skies were in a very hazy condition at this time and the moon interfered, so that the object was not observed until September 29. The condition of the sky prevented its being seen with the naked eye for some days, but from October 3 to October 13, when the moon again interfered, it was faintly visible without the telescope as a 5½ or 6th magnitude star.

In hopes that the comet would perhaps show some phenomena of interest, I made a series of photographs of it with the Bruce 10-inch and 6-inch lenses. These photographs showed a slender faint tail, whose maximum length was about 7°. There was very little change from night to night in the appearance of the tail. But on October 14 it was bifurcated at a distance of ½° from the head.

One rather remarkable feature about the comet was the persistence of a second very short tail at a very large angle to the main tail, on the south side of the head. This has been present in all the photographs, the angle between it and the main tail apparently becoming greater, until in the last photographs it was nearly at right angles to the main tail. It is intended to carefully measure this angle for a study of its changes. It would seem improbable that the comet's tail had any rotation because this short tail remained persistently on one side of the comet throughout the observations.

There was also for a few days, a very thin streamer about ½° long on the north side at a very small angle to the tail. This is shown on October 3, 4, 5 and 7. It was not visible on the 12th and following dates.

On October 4 the main tail was slender for ¼°, then widened considerably, and on October 5 it was slender for about ½° and then also widened considerably. Apparently this widening effect was receding from the comet, and was the same on both these dates.

After the first observation, the tail was visible in the 5-inch guiding telescope.

Following is a list of the photographs so far obtained.

Date				Exposure		Length of tail		Remarks
						10-inch	6-inch	
	d	h	m	h	m	°		
1911 Sept.	29	6	57	0	29	½	trace	Sky very thick
	30	7	16	0	54	1½	4	Sky fair
Oct.	1	6	47	0	25	3	4½	
	2	7	15	0	42	short	0	Sky poor and passing clouds
	3	7	20	1	16	5	5	Sky fairly good
	4	7	19	1	18	3½	5	
	5	7	12	1	21	4	5	Sky poor
	6	7	5	0	52	2	3	Sky very white and misty
	7	7	18	1	35	5	7	Sky good at first and poor later
	12	7	9	1	42	4	7	Sky only fair
	13	7	8	1	30	4½	6	Sky dull and thick
	14	7	16	1	42	4¾	6	Sky only fair. Moon
	15	7	26	1	33	3	6½	Moon
	16	7	12	1	49	4½	6½	Strong moonlight
	17	7	16	1	43	5	6	" "
	18					4	6	" "
	19	6	52	1	13	4½	5	" "

All the times are Central Standard Time ($6^h\ 0^m$ slow of G.M.T.)

On October 15 Dr. S. A. Mitchell kindly made the exposure for me.

Some of these pictures may be worthy of reproduction, but I cannot now take the time to prepare them for the purpose. The last photographs have been made in moonlight, but the tail shows almost as well as in those made on a dark sky—doubtless due to the increasing altitude of the comet.

Yerkes Observatory,
Williams Bay, Wis., 1912 October 20.

LEWIS BOSS.

R. H. TUCKER.

The personal characteristics of leading men of science will always be a subject of interest, especially to those who are working in the same branch. It is a legitimate interest, and a proper subject of discussion, within the bounds which intimate knowledge and a true perspective naturally afford.

It is possible that the true perspective of a man's work and character can not be gained by those living with him, or in his time; but this will be less doubtful as regards the man than in the case of great contributions to science, which may be expected to attain their proper proportions only when the results shall have been fully analyzed, and when they shall have become the common heritage of scientific men. The subject should be taken up without presumption, and treated without prejudice.

The work of Lewis Boss was practically all done in the line that is often described now as the old astronomy, the investigation of the positions and motions of the stars. This description is employed to distinguish the work from that which deals with the physical and chemical nature of the stars and planets, and with their history and evolution. His investigations were founded partly on his own observations, but more liberally, and on a great scale, from all the important results of meridian observations.

For two generations, following the construction of fine instruments, and the development of precise methods of reduction, this line of work may be said to have occupied the principal portion of the time and of the energies of astronomers, at all the leading observatories of the world.

In his wide acquaintance with all the important contributions to the subject of star positions, in his method of discussing the observations and handling the results, and in his insight into the principles of the methods employed, Lewis Boss had no peer in this country and he ranks with the best investigators of all countries, in this subject.

He gained this knowledge of his science, and this position in astronomy, by the most intense and nearly constant concentration. If there were times when his own work seemed to lag,

and when his attention seemed to have been diverted, these gaps were temporary, and even appear to have been the necessary means of recuperation for a fresh and more vigorous effort along the main track.

His interest in all the varied branches of modern astronomy was always keen, and his information was accurate and full. Absorption in his special researches did not prevent his keeping up with progress in others, to which he made no direct contribution.

In civic affairs, in national politics and in those of his adopted state, he was often active; writing of them with vigor, and discussing them with clearness and force. He participated actively in at least one presidential campaign, and into the successful celebration of Albany's historical foundation he threw all the weight of his personal efforts.

He had a predilection for diplomacy, of the direct and efficient form, which is coming to be recognized as an American characteristic. Its efficiency depends upon knowledge of human nature, and upon frank and open moves in the game. He was very quick to seize the salient points in any scheme, and to form his judgement of character and ability in those whom he met.

He did not hesitate to uphold his own opinion upon any subject, and some of his scientific discussions openly contested the conclusions of the leaders in his profession. He accepted no result as entirely valid, until he had personally tested all the details.

This does not imply an aggressive attitude only. His charm of talk and manner was heightened by quick humor, and the ability to see the other point of view, even if he would not admit the acceptance of it. He was a man of much natural dignity, and entirely without pretense of manner.

To many of the younger generation of astronomers the isolation of a man in his devotion to such extended and difficult researches has acted as a bar to acquaintance and appreciation. Men most distinguished in the profession have also felt that Professor Boss might be a difficult man to know, and one not likely to give any credit to ability and endeavor along other lines than his own. Fortunately, nearly all the leading men of science in this country had opportunity of personal acquaintance with him, sooner or later, and generally with mutual benefit. For the direct friction of speech and free discussion often lead to more perfect understanding, and to the appreciation of character and of effort. He was a thoroughly

delightful talker, taking up a train of thought, or a new train of ideas, promptly, and expanding them as he went on. In his particular and chosen work he developed his plans, and widened his horizon, in the process of merely describing the aim and objects in view. One of his friends, of wide cosmopolitan experience, has mentioned him as a conversationalist who never became tedious, even when discussing his own affairs exclusively.

For the members of his observatory staff Professor Boss was a stimulating man to work with, infusing with something of his own energy, and possibly something of his own enthusiasm, all those who started with the right spirit. There was usually bred a tone of loyalty to the work in hand, and a conviction of its importance, that aided substantially in the accomplishment. No special encouragement was given to individual efforts in separate schemes of work, but opportunity was often afforded for subordinate investigations along the main line. Accustomed to the direct supervision of every detail of his plans, it was necessary for him to clearly follow the execution of all these details to assure himself that they could be satisfactory. His mind was broad enough for the grasp of great problems, while occupied, with searching insight and thoroughness, upon all the separate items that must be joined for the perfect completion of the design. He was liberal in acknowledging the aid given to the prosecution of investigations carried out under his direction, but he was not receptive to independent suggestions, and true collaboration of work was very difficult for him to adopt. His ideas and his plans were in all ways self-sufficient, and often original.

His completed work, and the investigations still to be carried out should give the clearest illustrations of his character, and of the manner in which his plans were developed and expanded.

He was born at Providence R. I., October 26, 1846, of the best New England parentage. As a boy he showed some trace at least of his future taste for astronomy, specialized as it was, for he tested the daily motions of the stars by watching them pass across the vertical line of a building, with a true boy's enthusiasm in a practical illustration of what he had learned.

He was graduated from Dartmouth College in 1870. There he received the classical training, that, joined with his clear and vigorous mind, made him a writer of pure and forcible English, whether he wrote of scientific problems, or upon politics, or subjects in other fields of thought. Professor Boss often expressed a regret that he had not received a wider early training

in mathematics; but he was able to make up by practice, and by experience, deficiencies in the lines for which his college course had fitted him to train himself.

The course in astronomy was then given at Dartmouth by Professor Charles Young, afterward for so many years Director of Princeton Observatory, and a writer of text-books and of popular works that are widely used. As a student, Lewis Boss does not appear to have specialized in astronomy, in the sense that the term is now used, but his earliest independent work shows the trend of his inclinations, at a time when few opportunities were open for professional engagements. While occupied in the Government Land Office at Washington he took up the practice of the sextant, in his spare hours. This is a beautiful instrument for the illustration of practical methods of observing, and but few of these who handle it from the deck of a ship or the bridge of a liner, can truly appreciate all its uses, or its limiting imperfections. These he set himself to conquer, from enthusiastic interest in the problems.

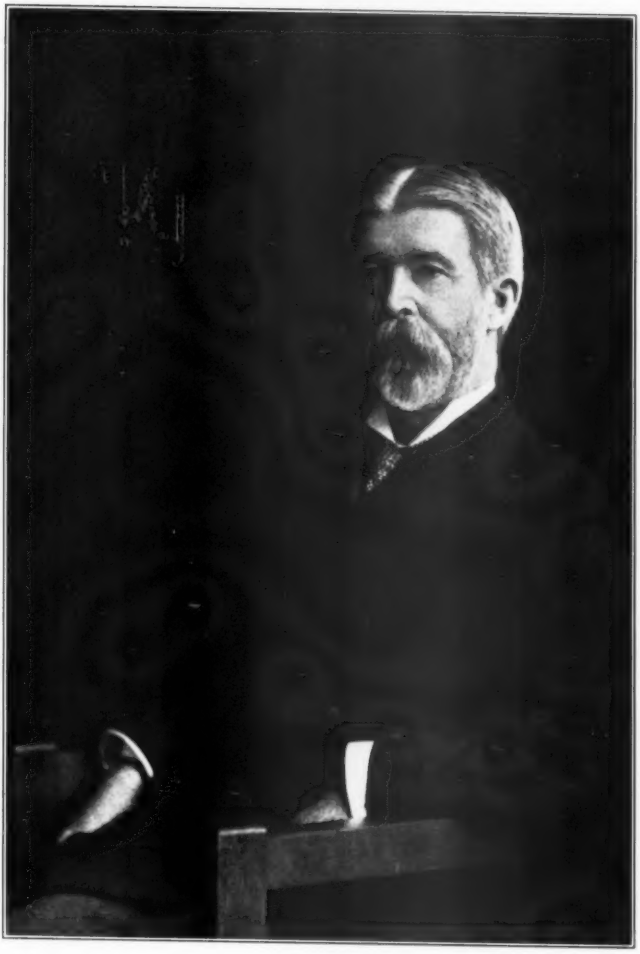
At that time the staff at the Naval Observatory included many of the best known men in the old Astronomy; Professors Newcomb, Hall, Holden, Eastman, Harkness and Frisby, with all of whom he eventually became acquainted.

Our government was then planning to complete the survey, and delineate the Northern boundary, from the Lake of the Woods westward, in collaboration with the government of Canada. For this purpose a commission was appointed by each government, and Lewis Boss was made assistant astronomer on the United States commission, under Major W. J. Twining, of the U. S. Engineer Corps. The field work was performed in the course of two summers, while the winters were spent in Washington, carrying on the necessary reductions. Associated with the commission, for the topographical work, was Professor C. L. Doolittle, later for many years Professor of astronomy at Lehigh University, and at the University of Pennsylvania.

The preliminary sextant work, for the location of the working camps, was done by Professor Boss, and he followed the first approximate determination of the latitude with a long series of zenith telescope observations at each station. The boundary marks were finally set by survey parties, in conformity with the latitude results obtained with the zenith telescope.

In order to provide the best possible places for the latitude

PLATE XXXII.



LEWIS BOSS
1846–1912

stars, it was necessary to search for early meridian observations, and to compile and discuss the results from the various sources then existing.

The investigation of the corrections required by the various catalogues, to reduce them to uniformity, led to the expansion of the original plan, and Professor Boss was fairly launched upon that series of researches upon stellar positions and motions, that was to occupy the greater part of the balance of his active life. The development and expansion of the scheme is the best illustration of the manner in which his later projects took shape in his mind, and were put into execution. He derived fundamental declinations for over three hundred of the principal stars, and combined the results, with those of the stars of the boundary survey, into his *Catalogue of 500 Declinations*, which forms an appendix to the Report of the Northern Boundary Commission for 1878. The system of standard declinations in this catalogue has been adopted for many purposes, and has been recognized as the best system derived up to that time.

Soon after the completion of his engagement upon the northern boundary, he was appointed Director of the Dudley Observatory in 1876. At this time the old institution in Albany was in a state of depression, following a period of inactivity, at the end of a quarter of a century of somewhat stormy history. It needed the tact and the energy of an efficient director to revive the fortunes of the observatory, and the success of the new outcome was soon assured. The observatory had been founded in 1851, partly as the result of the wave of popular interest in astronomy that swept over this country, following the apparition of the great comet of 1843. This interest was greatly stimulated by General O. M. Mitchel, a wonderful popular lecturer, who promoted the establishment of the observatory at Cincinnati, by his public lectures, and by his personal efforts in raising the necessary funds. The Naval Observatory at Washington was aided by this same wave of astronomical enthusiasm, though its design and its career have been far removed from popularization of the science.

The earliest Director at Albany was Dr. B. A. Gould, the first professionally educated American Astronomer, then fresh from his courses under the most eminent men practicing the profession in Germany. The observatory was formally dedicated in 1856, when the American Association for the advancement of Science met at Albany. The speaker of the occasion was

Edward Everett, whose beautiful address upon the popular features of astronomy was a text-book selection that many students of the past generation will recall.

The full history of the Dudley Observatory has never been written, and it was often the expressed desire of Professor Boss to fill this gap in the dispassionate spirit of the scientific historian. The subject will probably never be properly treated in full, and it is perhaps better that the old discussions that at one time involved prominent men in all sciences, in this country, be left to fade entirely from recollection. In the history of the activities of the observatory, mention would be made of Dr. S. C. Chandler, investigator of the latitude variation and for a long time editor of the Astronomical Journal, Professor Peters of Hamilton College, discoverer of many asteroids, Sontagg, who lost his life on Hayes Arctic expedition, Sterling, Professor Hough of Dearborn Observatory and Northwestern University, and General Mitchel, who died from exposure during the war, while on leave from the observatory.

The observatory was temporarily in the care of the U. S. Signal Corps, later developed into our present Weather Bureau, when Professor Boss took charge. The instruments were a thirteen-inch Fitz refractor, a large transit instrument, and the eight-inch Pistor and Martins meridian circle. With this last instrument, the observation of a zone of the *Astronomische Gesellschaft* was undertaken, as soon as the observatory was in complete working condition. This zone, $+1°$ to $+5°$, had been taken by the observatory at Zurich when the scheme of northern zones was first planned, but the work had been practically abandoned, and the Dudley Observatory was authorized to fill the gap thus caused. Many of the observatories had begun work in 1869, and it had been planned to complete all the observations so as to have the mean epoch fall at about 1875. It was important that this undertaking, thus tardily begun, should be pushed to completion with promptness, and to this accomplishment Professor Boss brought a great store of energy and enthusiasm. He was in perfect physical health, the life at the observatory was simple and free from outside distractions, with, however, much of intimate companionship. The zones observed were planned for two to four hours in length, and often two zones were taken in one night. Professor Boss observed all the transits, and there were three assistants, engaged at various times, for reading the circle microscopes. Some preliminary observations were made in 1878, but it was not until

the last half of 1879 that consecutive and sustained work was begun, to count towards the required number of observations. These were finished three years later, though not all the time included had been employed in observing. The reductions were carried forward promptly, and the zone catalogue was printed in 1890, the first year in which any of the published zones appeared. The last one of the northern zones has recently been printed, that of Berlin C in 1910, but this was observed in place of the Dorpat zone, the last of the remaining zones of the scheme having been published in 1902. The scheme of covering the northern sky has thus required a full generation, as commonly reckoned, and the corresponding scheme for the southern sky down to -23° has been under execution for the past quarter of a century.

The observations of the Albany zone were made with all the refinements possible in truly differential work. The graduation errors for every division employed for the zone stars were measured, observations for magnitude equation were made, and, in the reductions, the correspondence of the separate fundamental stars with the mean system was investigated. The observed places of the zone stars were compared with those of all the older catalogues, in the systematic manner that was a feature of the Director's work. About twenty thousand observations were made, and the catalogue contains closely the usual proportion of stars, 8241 for the four degrees. The probable errors of observation were small, for this class of work, less than $\pm 0.''6$ for a single observation in either coördinate, which is but little over half the limit of error allowed for the A. G. zones. This result should be attributed, in large part, to the excellence and thoroughness of the methods of reduction.

Among the European observers, the A. G. zones work embraced such distinguished names as those of Auwers, Becker, Bruns, Bakhuysen, Dubiago, Dunér, Deichmuller, Geelmuyden, Graham, Krueger, Seeliger, Valentiner, Wilterdink, and others, besides Rogers of Harvard in this country.

Towards the close of the zone work in 1882 Prof. Boss was appointed chief of one of the eight U. S. Government Transit of Venus parties, being the only civilian not actually in government employ to be thus distinguished. He was absent from the Dudley Observatory for six months, including the preliminary practice at Washington. During this interval, the great comet of 1882 made its appearance, and was regularly observed at Albany. Partial contacts for the Transit of Venus were

also observed at a station established by the Dudley Observatory in the mountains near Albany, the observation of the phenomena having been been interrupted by clouds, in a month, December, that was notable throughout for stormy weather.

The expedition of Prof. Boss, at Santiago, Chile, was favored with the best conditions, in the summer of that latitude, and a full series of photographs of the transit was secured, more than required for this portion of the program. These were later measured and reduced at Washington, without his further active coöperation. His party included Miles Rock, a graduate of Lehigh University, one of the first assistants to go to Cordoba with Dr. Gould in 1870 and at the date of the transit an assistant in the Naval Observatory. He was afterwards chief of the boundary commission for the limits between Mexico and Guatemala, and died there, in service. The remaining members of the party were two professional photographers, who were up to that time unacquainted with celestial photography, while neither of the astronomers was familiar with photography in any form.

The party was shown great courtesy by the Chilian Government, which at that time had not bred the strained relations with our own government, now happily quite removed again from the sphere of diplomacy.

In 1878 Professor Boss had observed the total eclipse of the sun, in Colorado, in company with a large number of American astronomers, Washington having been especially well represented. Or course no photographs were taken at that date, the photographic attack upon the problem having developed since the introduction of dry plates. In contrast, the first eclipse of the present year was photographed with cinematograph, to show the changes in the spectra at the limb of the sun.

Following the close of the computations for the zone reduction, rather dull times ensued at the observatory. The site was not favorable for the best observing, owing to the near proximity of the railroad, below the hill, on the north, and to the full extension of the width of the city towards the south. The living conditions for a growing family also left much to be desired, both from the isolation, and from the approach to the observatory, which bordered on one of the worst quarters of the city. The Director had removed his home to the center of town, and was in hopes that the observatory might eventually be removed to a better site. He took up newspaper

work, and actively entered the political campaign of 1884, that resulted in the election of Cleveland for president. Had the republican candidate of that year been elected, it is more than probable that Lewis Boss would have given up his astronomical work for a more public career. He had always been a warm admirer of James G. Blaine, and was as earnest in his partisanship as he was in all his opinions. He was, for a year, editor and manager of the Albany Express, and, notwithstanding his political affiliations, he was intimate personally with many strong men in the state government of the capital city.

Much comet work was done in those days at Dudley Observatory, under his direction, and it became a center for the computation of orbits and ephemerides. An original impetus had been given to this work by the discovery of a particularly interesting comet by C. S. Wells, at the observatory, in 1882. This comet had a small tail at the time of discovery, but, though it passed very close to the sun, the tail never developed to any great size, while the nucleus was bright enough to be observed with the meridian circle, in full daylight, nearly up to noon.

The comet apparently lacked a supply of hydrogen, and of the hydro-carbons that produce the most extensive tails, and the element of sodium seems to have been proved to be present. The Director was assisted in comet work by Prof. H. V. Egbert, one of the group of men that came from the old Cincinnati Observatory, and that have become distinguished in our own time in Astronomy.

Earlier than this, in 1881, Professor Boss had won a prize essay upon the subject of comets, among a large number of competitors, who were not known to the judges until the award had been made. The title of the essay, decided upon in advance for all competitors, included their origin, destiny, and meaning,— as well as the conditions are now recalled,—and it gave the writer a wide selection of what not to say in the best possible manner. Professor Boss did not devote much effort to the popularization of astronomy, and even his public lectures upon the sun, which were given with stereopticon illustrations, may be conceived as having other objects in view than that of merely arousing popular interest in the study. But the lectures were vivid, and always well adapted to his audiences; while his popular writings upon any scientific subject were governed by moderation, and yet extremely entertaining to educated readers.

Finally, his project for the removal of the Dudley Observatory to a new site was made possible, mainly by the liberal contributions of Miss Bruce of New York, aided substantially by the exchange of property with the city of Albany. The new observatory, completed in 1893, is located in an extension of the city park. It has the dome for the equatorial, the computing rooms, and a residence for the Director, in one building, and a separate steel walled building of modern design, for the transit circle. When this instrument was removed to the new site, several repairs and improvements were made, and the circles were newly graduated by Warner and Swasey, of Cleveland. A new equatorial was purchased, with lens by Brashear, and a complete outfit of auxiliary apparatus, including a spectroscope, was provided for this instrument. But meridian circle work has always been the principal contribution from this observatory, including researches along the closely affiliated lines of star positions and motions.

The graduation errors were measured for the newly divided circles, extending the measurements down to 10′ divisions, between which the existence of marked periodicity makes it possible to interpolate closely the errors of the 2′ divisions. Steady progress was made in the reduction and discussion of existing catalogues of star positions, and the plans of the Director began to take shape for his monumental contribution to astronomy, as he would certainly have wished it to be described, the preparation of a great catalogue of 25,000 stars, the places of which should be reduced to a uniform system, and should be based upon all existing observations of good quality, with the added strength of modern determinations of position, some of which, at least, should be made with the Albany instrument. His own physical disabilities prevented his taking a large share in the observing, but the initial series of some ten thousand observations were made at the new Dudley Observatory under his direction, principally by assistants A. J. Roy and W. B. Varnum. An essential part of his plan, constantly under discussion since the removal to the new site, had been the acquirement of the necessary observations in the southern hemisphere, as the catalogue was to include the whole sky. For the elimination of some sources of error, and in order that there might be homogeneous methods of observation and reduction, a series of observations was planned for the southern stars, to be made with the same

instrument used at Albany, and to be finally reduced there, in combination with the northern observations.

Meantime the Carnegie Institution of Washington had come to his aid, with a most substantial grant, of ten years duration, to further all parts of the general design. He was made Director of the Department of Meridian Astrometry, specially created for this purpose, in 1904. Realizing that he would not be able to attend personally to the execution of the work in the southern hemisphere, he asked me to take charge of the observations to be made there, and for that purpose, in 1908, I obtained a three years leave of absence from the Lick Observatory. This period proved to be sufficient for the erection of the observatory, and for the accumulation of 87,000 observations, fulfilling in every respect the requirements of the plan as to distribution, fundamental determinations, refraction and reflection observations, measurement of instrumental errors, the preparation of the computations for final reduction, and finally for the transport of apparatus and results back to Albany, in the spring of 1911. The Meridian Circle, with which these observations were made, had been in service for more than fifty years.

Professor Boss made two trips to San Luis, Argentina, which had been decided upon as the location of the temporary observatory before starting on the first trip.

During his first visit of a few days, in 1908, he accepted the site, which had been provisionally selected by Mr. Walter G. Davis, formerly of the National Observatory at Cordoba, and now chief of the Argentine Meteorological Service, and he witnessed the first preparations for the construction of the observatory. The voyage out renewed his strength and his spirits in a remarkable degree, and though he suffered shipwreck on the return, it is not likely that even the exposure and hardships incidental to this experience lessened his vitality to any extent. He had been free from all care in the preparation, and in the transportation of all the materials for construction, and of the equipment, taken out on this preliminary trip. And there were no difficulties for him to encounter in making his first visit to a country, with whose language and customs he was entirely unfamiliar. He was most courteously treated by many of the Argentines, and by foreigners resident there; and he had many opportunities for the exchange of compliments, and diplomatic civilities, with government officials, in the capital city of Buenos Aires.

He returned to San Luis four months later, to find the observatory completely built for the installation of the instrument, which he brought out on this second trip, and the house entirely ready for occupancy by the full staff. With him came the larger number of the assistants, bringing the observing force up to seven. Later three more men were sent out, and for a short period the staff included ten men; Messrs. Roy, Varnum and Zimmer of the Dudley Observatory, Mr. Sanford, formerly of Lick, and five recent engineering graduates, Messrs. Fair, Delevan, Mearns, Roy and Jenkins, these latter employed as microscope readers, there being five practiced telescope observers.

Professor Boss remained in the country two months, on this second visit, in which period the instrument was mounted, long series of determination of flexure, pivot error, and graduation error were made, and the first observations on the regular program were started. He returned by way of Europe, the last visit that he paid to his many friends on that side of the Ocean. Certainly the vigor with which he entered into the simple and busy life at the new observatory, and the physical as well as mental stimulus he appeared to derive from the visible active operation of his long cherished plans, gave every one reason to hope for him a long extended and fruitful career. His ailments were chronic and severe, and had been complicated undoubtedly by the entirely sedentary habits he had formed in much earlier years, by neglect of ordinary precaution in his manner of living, and especially by periods of excessive application to desk work. He was fully aware of all this, and of the possible outcome. Sudden and severe attacks had often led to temporary collapse, that had given him plain warning, and had been most alarming to those with him. He had remarkable powers of recuperation, and a physique that should have endured much longer, under other usage. He frankly and somewhat whimsically admitted his defiance of all laws in his manner of life.

There was a competent force of computers established at Albany, to take up the reductions from the southern observatory, as the preliminary computations were forwarded by mail. While the work in the southern hemisphere was going on, the Preliminary General Catalogue was completed, and published by the Carnegie Institution in 1910. This contains 6188 stars, and forms the basis of the larger catalogue, in preparation. It has gained immediate recognition, as the best extensive cata-

logue of standard stars. Several separate contributions to the subject of star positions, especially relating to the southern stars, have been published in the Astronomical Journal, but the Preliminary General Catalogue replaces all previous compilations, which Professor Boss had regarded as tentative solutions, and this is to be considered as the culmination of his many years of research, for the stars included.

One of the immediate fruits of the compilation of proper motions for this catalogue was his recent detection of the Taurus stream of stars, moving in the same general direction in space. The solution of this problem was reached in 1908, at the time preparations were being made for despatching the first party to South America.

These last two contributions to astronomy are excellent illustrations of his scientific life: the successive approximations to a more perfect system of star places, each approximation, as finished, acting as a spur to further and more extensive research; and the successful development of a by-product, so important in significance, while his most elaborate scheme was hanging in the balance.

He assumed the editorship of the Astronomical Journal in 1909, having been for several years previously an associate editor. During the years 1884 to 1894 he was State Superintendent of weights and measures, Albany being an important center for the State scientific bureaus, among them the State Museum, which has included some distinguished men of all branches on its staff.

The local scientific society, the Albany institute, is the second oldest in this country, and several members of the observatory staff have contributed to its activities.

Professor Boss was long a member of the National Academy of Sciences, and very rarely failed to attend the meetings in Washington. Less often did he appear at the meetings of the American Association for the Advancement of Science, and at those of the Astronomical and Astrophysical Society. At the Saratoga meeting of the former, in 1879, he presented a paper in person, upon the observations of the asteroids for solar parallax. He had been a member of the Astronomische Gesellschaft since the date of his directorship at Albany.

His researches upon stellar positions and motions were recognized by the presentation of the gold medal of the Royal Astronomical Society in 1905, and by the Lalande prize of the Paris Academy in 1911. He was a Foreign Associate of the

Royal Astronomical Society, a corresponding member of the British Association, of the Prussian Academy and of the St. Petersburg Academy. The honorary degree of A. M. was conferred upon him by Dartmouth in 1877, of L. L. D. by Union in 1902, and of Sc.D. by Syracuse in 1910, and by Dartmouth in 1912. He died at his home at the observatory on October fifth, after several months of such severe prostration that hope of his ultimate recovery had been practically abandoned.

The Dudley Observatory has been nominally a department of Union College for many years, and the Director ranks as Professor on the college faculty. Most of his honorary titles came late in life, long after the substantial recognition of the excellence and the enduring character of his work, by the astronomers of the world. He was married to Miss Helen Hutchinson of Washington in 1871, and is survived by his widow, his three daughters, Mrs. Farnsworth, Mrs. McElroy, and Mrs. Green, and his son Benjamin Boss, secretary of the Department of which his father was the head.

Lick Observatory, Oct. 19, 1912.

PLANET NOTES FOR DECEMBER, 1912.

The sun reaches its farthest point south on Sunday, Dec. 22. At this date the sun enters the sign of the zodiac, Capricornus, and it is the date when, according to the almanac, winter begins. By the end of the month the sun will be moving northward at the rate of 4 minutes of arc a day. The sun will pass from the constellation Scorpio into the constellation Sagittarius during the month.

The phases of the moon for this month are as follows:

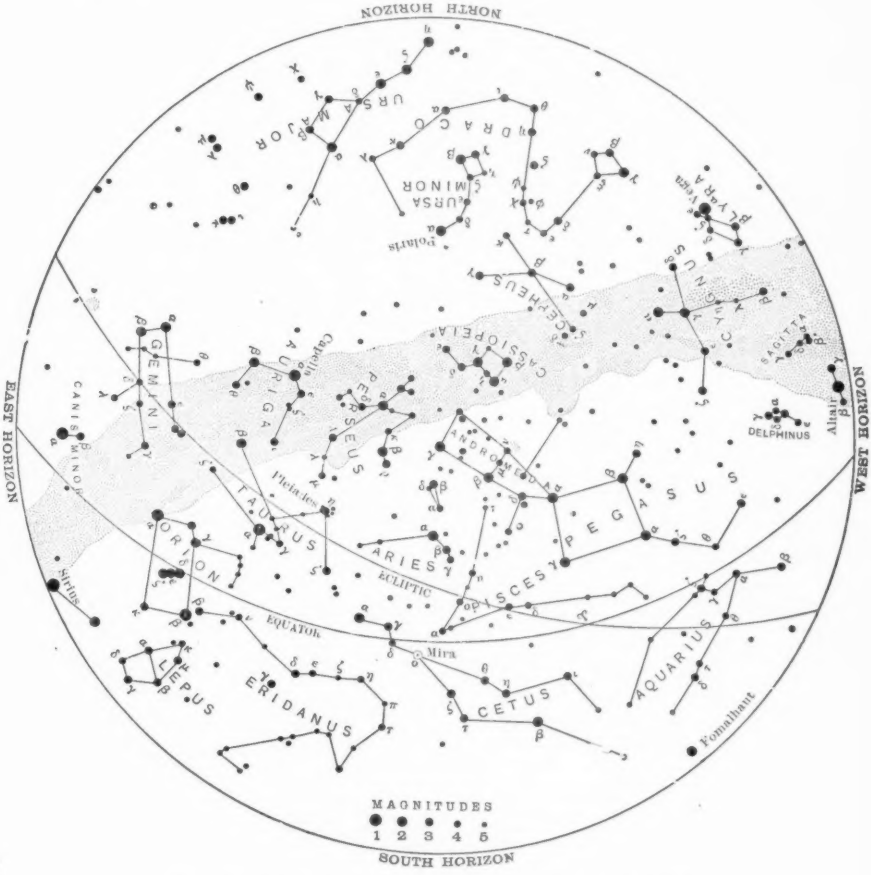
New Moon	Dec.	8	at 11 A. M.	C.S.T.
First Quarter		16	" 2 P. M.	"
Full Moon		23	" 10 P. M.	"
Last Quarter		30	" 2 P. M.	"

Mercury will move westward nearly the entire month. It will reach a period of greatest elongation west on Dec. 27. At this time it will be about an hour and a half east and about two degrees north of the sun. Near this date it will be plainly visible in the eastern sky just before sunrise. Inasmuch as Mercury is usually too close to the sun to be seen, it is always interesting when it can be seen. The appearance at this season of the year is especially favorable because the sun rises so late that any one can conveniently look for Mercury at the time when it is visible.

Venus will be visible in the evening sky during the month. It is moving eastward more rapidly than the sun and by the end of the month will be about three hours east and seven degrees north of the sun. It will then be a most brilliant object.

The *Earth* will be at perihelion, point nearest to the sun, on Dec. 31 at 2 P.M. C.S.T. At this time the earth will be more than three million miles nearer the sun than when it is at its greatest distance.

Mars will be very near the sun during the month and will therefore be invisible except possibly near the close of the month when it will rise a little more than an hour before the sun. It will not be well situated for observation. Mars is approaching the earth. At the close of the month it will have the magnitude 1.6.



THE CONSTELLATIONS AT 9:00 P. M. DECEMBER 1, 1912.

Jupiter will be lost in the rays of the sun during this month. It will be in conjunction with the sun on Dec 18. At this date it will be less than half the angular diameter of the moon from the sun. This will be an interesting phenomenon but will be impossible to observe on account of the intense light of the sun.

Saturn will still be very well situated for observation. It will be well above the eastern horizon at sunset, and will be visible nearly all night. It will be of magnitude 0.0, hence a little brighter than Vega, the brightest star north of the equator.

Uranus will be getting near the sun. It will be visible in the southwest just after sunset.

Neptune will rise a few hours after sunset. It is moving slowly westward in the constellation Gemini.

During this month all the planets except Saturn and Neptune will be south of the equator.

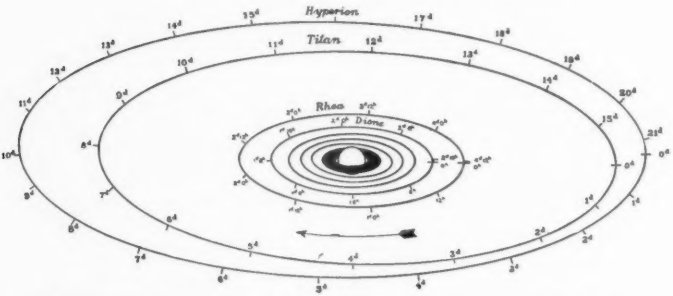
Occultations visible at Washington.

Date 1912	Star's Name	Magnitude	IMMERSION. Washington M.T. h m	IMMERSION. Angle from N. °	EMERSION. Washington M.T. h m	EMERSION. Angle from N °	Duration h m
Dec. 11	A Sagittarii	4.9	3 47	45	5 5	267	1 18
14	182 B Aquarii	6.2	8 58	60	10 2	233	1 4
19	19 Arietis	5.8	9 12	99	10 14	197	1 2
20	ξ Arietis	5.0	14 44	125	15 23	210	0 39
23	415 B Tauri	6.1	4 50	123	5 27	218	0 37
24	47 Geminorum	5.6	6 09	108	6 58	49	0 49
24	134 B Geminorum	6.5	8 37	166	8 52	194	0 15
25	λ Cancri	5.9	7 42	78	8 34	296	0 52
28	σ Leonis	4.1	12 36	88	13 31	337	0 55
40	*g* Virginis	5.6	18 16	129	19 35	311	1 19

Saturn's Satellites.

CENTRAL STANDARD TIME.

E = eastern elongation; W = western elongation.
I = interior conjunction; S = superior conjunction.



APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, at date of opposition, November 23, 1912, as seen in an inverting telescope.

I. Mimas. Period $0^d\ 22^h.6$.

		h			h			h			h
Dec.	1	12.8 E	Dec.	10	11.7 W	Dec.	18	11.8 E	Dec.	25	13.5 W
	2	11.4 E		11	10.3 W		19	10 4 E		26	12.1 W
	3	10.0 E		12	8.9 W		20	9.1 E		27	10.7 W
	4	8.6 E		13	7.5 W		21	7.7 E		28	9.3 W
	5	7.2 E		14	6.1 W		22	6.3 E		29	7.9 W
	6	5.8 E		15	4.7 W		23	4.9 E		30	6.5 W
	8	14.4 W		16	14.6 E		24	14.9 W		31	5.1 W
	9	13.0 W		17	13.2 E						

II. Enceladus. Period $1^d\ 8^h.9$.

Dec.	1	16.1 E	Dec.	9	21.3 E	Dec.	18	2.6 E	Dec.	26	7.9 E
	3	1.0 E		11	6.2 E		19	11.5 E		27	16.8 E
	4	9.9 E		12	15.1 E		20	20.4 E		29	1.7 E
	5	18.7 E		13	23.9 E		22	5.3 E		30	10.5 E
	7	3.6 E		15	8.8 E		23	14.1 E		31	19.4 E
	8	12.5 E		16	17.7 E		24	23.0 E			

III. Tethys. Period $1^d\ 21^h.3$.

Dec.	1	5.5 E	Dec.	10	15.7 E	Dec.	18	4.9 E	Dec.	25	18.1 E
	3	2.6 E		12	13.0 E		20	2.2 E		27	15.4 E
	4	23.9 E		14	10.3 E		21	23.5 E		29	12.7 E
	6	21.1 E		16	7.6 E		23	20.8 E		31	9.9 E
	8	18.4 E									

IV. Dione. Period $2^d\ 17^h.7$.

Dec.	3	15.4 E	Dec.	11	20.3 E	Dec.	20	1.3 E	Dec.	28	6.3 E
	6	9.1 E		14	14.0 E		22	19.0 E		30	23.9 E
	9	2.7 E		17	7.7 E		25	12.6 E			

V. Rhea. Period $4^d\ 12^h.5$.

Dec.	4	3.9 E	Dec.	13	4.6 E	Dec.	22	5.2 E	Dec.	31	5.9 E
	8	16.3 E		17	16.9 E		26	17.6 E			

VI. Titan. Period $15^d\ 23^h.3$.

Dec.	1	6.3 I	Dec.	8	23.6 S	Dec.	17	3.7 I	Dec.	24	21.0 S
	5	2.1 W		13	2.5 E		20	23.5 W		29	0.1 E

VII. Hyperion. Period $21^d\ 7^h.6$.

Dec.		^{d} 5.2 E	Dec.		^{d} 15.4 W	Dec.		^{d} 26.4 E	Dec.		^{d} 31.1 I
		9.9 I			21.3 S						

VIII. Japetus. Period $79^d\ 22^h.1$.

Dec.		2.1 S				Dec.		21.1 W			

IX. Phoebe. Period $580^d\ 4^h.7$.

		α Ph.—α Sat.			δ Ph.—δ Sat.				α Ph.—α Sat.			δ Ph.—δ Sat.	
		h	m	s	°	′			h	m	s	°	′
Dec.	1	2	40.2		+0	12.5		Dec. 21	2	28.0		0	12 2
	6	2	37.8		0	12.4		26	2	24.1		0	12.0
	11	2	34.9		0	12.3		31	2	19.9		+0	11.8
	16	2	31.6		0	12.3							

VARIABLE STARS.

Approximate Magnitudes of Variable Stars on Oct. 1, 1912.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h	m	Decl. 1900. °	′	Magn.	Name.	R.A. 1900. h	m	Decl. 1900. °	′	Magn.
X Androm.	0	10.8	+46	27	12.8	U Androm.	1	9.8	+40	11	<13.0
T Androm.		17.2	+26	26	8.3	— Androm.		10.4	+41	12	<14.0
T Cassiop.		17.8	+55	14	8.5*d*	S Cassiop.		12.3	+72	5	<12.0
R Androm.		18.8	+38	1	11.0	RZ Persei		23.6	+50	20	10.5*d*
S Ceti		19.0	− 9	53	<10.0	R Piscium		25.5	+ 2	22	<12.0
U Cassiop.		40.8	+47	43	8.8	RU Androm.		32.8	+38	10	12.5*d*
RW Androm.		41.9	+32	8	<12.0	Y Androm.		33.7	+38	50	9.3
RV Cassiop.		47.1	+46	53	<13.0	X Cassiop.		49.8	+58	46	9.5 *i*
W Cassiop.		49.0	+58	1	11.7 *i*	Z Cephei	2	12.8	+81	13	<13.0

Approximate Magnitudes of Variable Stars on Oct. 1, 1912.—Con.

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
o Ceti	2 14.3	− 3 26	7.7	RS Ophiuchi	17 44.8	− 6 40	<11.0
S Persei	15.7	+58 8	8.8	T Draconis	54.8	+58 14	10.7*d*
RR Persei	21.7	+50 49	13.3*d*	RY Herculis	55.4	+19 29	<11.0
U Ceti	28.9	−13 35	9.2*d*	V Draconis	56.3	+54 53	10.1
RR Cephei	29.4	+80 42	<13.0	T Herculis	18 5.3	+31 0	<12.0
R Trianguli	31.0	+33 50	9.0 *i*	W Draconis	5.4	+65 56	12.2
Y Persei	3 20.9	+43 50	9.2	X Draconis	6.8	+66 8	<12.0
T Camelop	4 30.4	+65 57	12.8	RY Ophiuchi	11.6	+ 3 40	<11.0
— Tauri	32.8	+ 8 9	<12.0	SV Draconis	31.2	+49 18	10.0*d*
X Camelop.	32.6	+74 56	8.0	RY Lyrae	41.2	+34 34	12.5*d*
R Leporis	55.0	−14 57	9.4	Z Lyrae	56.0	+34 49	13.9
R Aurigae	5 9.2	+53 28	8.3 *i*	V Lyrae	19 5.2	+29 30	<13.0
S Aurigae	20.5	+34 4	8.9	S Lyrae	9.1	+25 50	10.6*d*
S Camelop	30.2	+68 45	9.5	UDraconis	9.9	+67 7	10.7*d*
U Orionis	49.9	+20 10	9.3*d*	U Lyrae	16.6	+37 42	10.6*d*
V Camelop.	49.4	+74 30	<12.0	R Cygni	34.1	+49 58	<12.0
V Monoc.	6 17.7	− 2 9	<12.0	RT Cygni	40.8	+48 32	8.1*d*
U Lyncis	31.8	+59 57	<13.0	χ Cygni	46.7	+32 40	4.7
Nova Gem. 2	45.5	+32 17	7.6	SV Cygni	20 6.5	+47 35	9.4
R Lyncis	53.0	+55 28	<12.0	S Aquilae	7.0	+15 19	9.5
RR Monoc.	7 12.4	+ 1 17	<13.0	RS Cygni	9.8	+38 28	7.8
S Can. Min.	27.3	+ 8 32	<11.0	R Delphini	10.1	+ 8 47	<11.0
R Cancri	8 11.0	+12 2	8.7*d*	V Sagittae	15.8	+20 47	10.7 *i*
Y Draconis	9 31.1	+78 18	12.7 *i*	U Cygni	16.5	+47 35	10.3
R Urs. Maj.	10 37.6	+69 18	7.6	SZ Cygni	29.6	+46 16	9.3
T Urs. Maj.	12 31.8	+60 2	<12.0	ST Cygni	29.9	+54 38	13.8
S Urs. Maj.	39.6	+61 38	12.0	V Cygni	38.1	+47 47	<11.0
T Urs. Min.	13 32.6	+73 56	<12.0	Y Aquarii	39.2	− 5 12	<12.0
R Can. Ven.	44.6	+40 2	10.9*d*	T Aquarii	44.7	− 5 31	<11.0
U Urs. Min.	14 15.1	+67 15	11.1*d*	R Vulpeculae	59.9	+23 26	11.0*d*
S Boötis	19.5	+54 16	9.3	VV Cygni	21 2.3	+45 23	<12.0
V Boötis	25.7	+39 18	8.6 *i*	X Cephei	3.6	+82 40	<12.0
R Camelop.	25.1	+84 17	8.6*d*	R Equulei	8.4	+12 23	<13.0
R Boötis	32.8	+27 10	8.6	T Cephei	8.2	+68 5	5.7
S Serpentis	15 17.0	+14 40	8.5 *i*	W Cygni	32.2	+44 56	6.6
S Cor. Bor.	17.3	+31 44	10.4 *i*	S Cephei	36.5	+78 10	<10.0
R Cor. Bor.	44.4	+28 28	6.3	RV Cygni	39.1	+37 34	7.7
R Serpentis	46.1	+15 26	10.7	S Lacertae	22 24.6	+39 48	<12.0
RU Herculis	16 6.0	+25 20	10.6*d*	S Aquarii	51.8	−20 53	<12.0
W Cor. Bor.	11.8	+38 3	9.7*d*	R Pegasi	23 1.6	+10 0	9.1 *i*
U Herculis	21.4	+19 7	<11.0	V Cassiop.	7.4	+59 8	8.2*d*
W Herculis	31.7	+37 32	12.3	W Pegasi	14.8	+25 44	8.4
R Urs. Min.	31.3	+72 28	9.7*d*	S Pegasi	15.5	+ 8 22	8.3
R Draconis	32.4	+66 58	11.4	ST Androm.	33.8	+35 13	9.4
S Herculis	47.4	+15 7	9.5 *i*	Z Cassiop.	39.7	+56 2	11.6*d*
RV Herculis	56.8	+31 22	9 7	R Cassiop.	53.3	+50 50	10.4*d*
R Ophiuchi	17 2.0	−15 58	<10.0	Y Cassiop.	58.2	+55 7	10.4 *i*
Z Ophiuchi	14.5	+ 1 37	9.4	SV Androm	59.2	+39 33	<12.0
RU Ophiuchi	28.5	+ 9 30	<11.0				

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign <, that the variable is fainter than the appended magnitude. The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:— T. C. H. Bouton, A. P. C. Craig, T. Dunham, E. L. Forsyth, Edward Gray, F. E. Hathorn, C. J. Hudson, S. E. Hunter, M. W. Jacobs, Jr., C. Y. McAteer, P. G. O'Reilly, Wm. T. Olcott, H. M. Swartz, H. W. Vrooman, I. E. Woods, and A. S. Young.

Minima of Variable Stars of the Algol Type.

[Calculated by Mary H. Wilson at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h, etc.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in **December** 1912 d h; d h; d h; d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.6	6 8
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	6 21; 12 20; 24 18; 30 16
U Cephei	0 53.4	+81 20	7.1— 9.2	2 11.8	4 11; 9 11; 19 10; 29 9
Z Persei	2 33.7	+41 46	9.4—12.	3 01.4	1 14; 7 17; 19 22; 26 1
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	3 10; 10 7; 24 0; 30 21
RZ Cassiop.	39.9	+69 13	6.4— 7.8	1 04.7	4 4; 10 3; 22 3; 28 2
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	5 22; 11 5; 21 19; 27 3
RX Cephei	2 58.8	+67 11	8.6— 9.1	32 07.6	3 22
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	4 4; 9 22; 21 9; 27 3
RT Persei	16.7	+46 12	9. —11.	0 20.4	2 18; 7 20; 18 1; 28 5
λ Tauri	55.1	+12 12	3.4— 4.5	3 22.9	6 18; 14 15; 22 13; 30 11
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	6 0; 10 13; 22 15; 28 4
RV Persei	4 04.2	+33 59	10.6—12.8	1 23.4	3 15; 9 13; 21 9; 27 7
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	3 22; 17 3; 30 8
RS Cephei	4 48.6	+80 06	9.5—12.2	12 10.1	11 16; 24 2
RY Aurigæ	5 11.5	+38 13	10.7—11.7	2 17.5	5 7; 10 18; 21 16; 27 3
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	1 9; 7 10; 19 11; 31 12
SV Gemin;	54.6	+24 28	9.8—<11	4 00.2	7 8; 15 9; 23 9; 31 9
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	1 7; 7 0; 18 11; 29 23
U Columbæ	6 11.2	−33 03	9.4—10.2	2 19.2	2 0; 7 15; 18 19; 30 0
SX Gemin.	22.	+20 37	10.8—11.5	1 08.8	5 2; 10 13; 21 11; 26 23
RW Monoc.	29.3	+ 8 54	9.0—10 8	1 21.7	2 5; 9 20; 17 11; 25 2
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	3 5; 15 10; 27 15
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	5 22; 11 7; 22 1; 27 10
R Canis Maj.	7 14.9	−16 12	5.9— 6.7	1 03.3	3 14; 9 6; 20 15; 31 23
RY Gemin.	7 21.7	+15 52	8.9—<10	9 07.2	8 5; 17 12; 26 20
Y Camelop	27.6	+76 17	9.5—12.	3 07.3	7 3; 13 18; 20 9; 26 23
RR Puppis	43.5	−41 08	9.5—	6 10.3	4 14; 11 0; 23 21; 30 7
V Puppis	55.4	−48 58	4. — 5.	1 10.9	3 24; 11 6; 18 13; 25 19
X Carinæ	8 29.1	−58 53	7.8— 8.9	0 13.0	4 10; 9 20; 20 16; 31 11
S Cancri	8 38.2	+19 24	8. —10.	9 11.6	5 4; 14 15; 24 3
S Velorum	9 29.5	−44 46	7.8— 9.5	5 22.4	1 8; 7 7; 19 4; 31 0
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	3 16; 12 2; 20 13; 28 23
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	3 20; 13 3; 22 9; 31 16
SS Carinæ	10 54.2	−61 23	12.2—12.8	3 07.2	1 14; 8 5; 21 10; 28 0
RW Urs. Maj	11 35.4	+52 34	9.3—10.3	7 07.9	5 4; 12 12; 19 20; 27 4
Z Draconis	11 40.6	+72 49	9.5—12.5	1 08.6	3 15; 10 10; 23 23; 30 18
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	2 5; 9 15; 24 12; 31 23
δ Libræ	14 55.6	— 8 07	5. — 6.7	2 07.9	1 8; 8 8; 22 7; 29 7
U Coronæ	15 14.1	+32 01	7.8— 9.0	3 10.9	7 12; 14 10; 21 8; 28 6
TW Draconis	15 32.4	+64 14	7.0— 8.9	2 19.4	3 0; 11 10; 19 20; 28 6
SW Ophiuchi	16 11.1	— 6 44	9.2—10.	2 10.7	4 10; 11 18; 19 2; 26 10
SX Ophiuchi	16 12.6	— 6 25	10.5—11.2	2 01.5	1 10; 7 15; 19 24; 26 4
R Aræ	16 31.1	−56 48	6.7— 8.	4 10.2	5 11; 14 8; 23 4
TT Herculis	16 49.9	+17 00	8.9— 9.5	20 18.1	14 7
TU Herculis	17 09.8	+30 50	9.5—12.	2 06.4	1 7; 8 2; 21 17; 28 12
U Ophiuchi	11.5	+ 1 19	6. — 6.7	0 20.1	2 7; 10 16; 19 1; 27 11
SZ Herculis	36.0	+33 01	9 5—10.3	0 19.6	1 17; 9 22; 18 2; 26 6
Z Herculis	17 53.6	+15 09	6.7— 8.0	3 23.8	1 7; 9 6; 17 6; 25 6
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	6 2; 11 6; 21 15; 31 23
RS Sagittarii	11.0	−34 08	6.7— 7.8	2 10.0	1 13; 8 18; 23 6; 30 12
V Serpentis	11.1	−15 34	9 5—	3 10.9	4 12; 11 10; 18 7; 25 5
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	3 4; 8 16; 19 16; 30 17

Minima of Variable Stars of the Algol Type.—Continued.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in December 1912. d h	d h	d h	d h
RX Herculis	18 26.0	+12 32	7.8— 8.0	0 21.3	5 5;	14 2;	22 23;	31 21
SX Sagittarii	39.7	−30 36	8.6— 9.4	2 01.8	3 18;	9 24;	22 11;	28 16
RR Draconis	40.8	+62 34	9.3—13.	2 19.9	7 12;	16 0;	24 12	
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	5 9;	11 24;	25 5;	31 19
U Scuti	18 48.9	−12 44	9.0— 9.8	0 22.9	1 22;	11 11;	21 0;	30 14
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.5	9 19;	19 6;	28 18	
RV Lyræ	12.5	+32 15	11. —13.	3 14.4	2 11;	9 16;	24 2;	31 6
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	9 18;	18 17;	27 15	
U Sagittæ	14.4	+19 26	6.7— 9.0	3 09.1	3 6;	9 24;	23 13;	30 7
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 15;	8 23;	23 17;	31 2
TT Lyræ	24.3	+41 30	9.0<11.0	5 05.8	1 8;	6 14;	17 1;	27 13
SY Cygni	19 42.7	+32 28	10. —12.	6 00.2	1 3;	7 3;	19 3;	31 4
WW Cygni	20 00.6	+41 18	9.5—12.5	3 07.6	4 15;	11 7;	24 13;	31 4
SW Cygni	03.8	+46 01	9. —12.	4 13.8	7 2;	16 6;	25 9	
VW Cygni	11.4	+34 12	9.5—11.5	8 10.3	9 3;	17 14;	25 24	
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	1 16;	8 11;	22 1;	28 19
UW Cygni	19.6	+42 55	10.5—13.	3 10.8	4 21;	11 19;	18 17;	25 14
W Delphini	33.1	+17 56	9.5—11.5	4 19.4	3 19;	13 9;	23 0	
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4		10 4;	19 9;	28 13
Y Cygni	48.1	+34 17	7. — 8.	1 12.0	4 7;	11 19;	19 7;	26 19
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 20;	9 21;	19 24;	30 2
VV Cygni	21 02.3	+45 23	11. —14.	1 11.4	7 15;	15 1;	22 10;	29 19
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	8 23;	18 16;	28 8	
UZ Cygni	55.2	+43 52	9. —11.5	31 07.3		13 14		
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	4 12;	9 13;	19 17;	29 20
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	3 0;	8 5;	18 14;	29 23
TT Androm	23 08.7	+45 36	10.5—11.3	2 18.3	7 23;	16 6;	24 13	
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	8 0;	15 13;	23 2;	30 15
TW Androm.	23 58.2	+32 17	8.6—11.5	6 02.9	5 5;	13 11;	21 17;	29 23

Maxima of Variable Stars of Short Period not of the Algol Type.

[Calculated by Wallace F. Johnson at Goodsell Observatory]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h etc. An * following the name of a star signifies that for that star times of minima instead of maxima are given.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of maxima in December 1912. d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	14 9			
SY Cassiop.	9.8	+57 52	9.3— 9.9	4 1.7	6 3;	14 6;	22 9;	30 13
RT Sculptor.*	0 31.5	−26 13	9.6—10.5	0 12.3	5 6;	10 9;	15 12;	25 17
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	1 0;	6 13;	17 14;	28 16
RW Cassiop.	1 30.7	+57 15	8.6— 9.4	14 19 2	4 7;	19 2		
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	4 23;	10 22;	22 19;	28 18
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	4 21;	10 17;	22 10;	28 6
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	4 13;	10 14;	22 18;	28 20
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	8 0;	24 0		
SX Persei	4 10.2	+41 29	10.3—11.0	4 07.1	4 18;	13 8;	21 22;	30 12
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	7 18;	18 21;	30 0	
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	8 14;	20 5;	31 20	
TT Aurigæ*	02.8	+39 27	7.8— 8.7	0 16.0	1 22;	8 14;	21 22;	28 14
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	3 8;	9 11;	21 17;	27 20

Maxima of Variable Stars of Short Period not of the Algol Type.

Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of maxima in December 1912.
	h m	° ′		d h	d h d h d h d h
SY Aurigæ	5 05.5	+42 42	9.0– 9.7	10 03.3	2 4; 12 7; 22 10
Y Aurigæ	21.5	+42 21	9. —	3 20.6	5 17; 13 11; 21 4; 28 21
SV Tauri*	45.8	+28 05	9.4–11.0	2 04.0	5 23; 12 11; 18 23; 31 23
RZ Gemin.	5 56.6	+22 15	9.1–10.0	5 12.7	2 10; 7 23; 19 0; 30 2
RS Orionis	6 16.5	+14 43	7.8– 8.5	7 13 4	2 23; 10 12; 18 2; 25 15
T Monoc.	19.8	+ 7 08	6. – 8.	27 00.3	26 5
RZ Camelop	23.7	+67 06	11.0–12.8	0 11.5	4 13; 9 9; 18 23; 28 14
W Gemin.	29.2	+15 24	6 8– 7.6	7 22.0	4 15; 12 13; 20 11; 28 9
ξ Gemin.	6 58.2	+20 43	3.7– 4.5	10 03.7	1 10; 11 14; 21 18; 31 21
RU Camelop.	7 10.9	+69 51	8.5– 9.8	22 06.5	20 22
RR Gemin.	7 15.2	+31 04	9.7–10.6	0 09.5	4 13; 8 12; 16 11; 24 9
V Carinæ	8 26.7	−59 47	7.2– 8.0	6 16.7	3 3; 9 20; 23 5; 29 22
T Velorum	8 34.4	−47 01	7.5– 8.5	4 15.3	3 20; 8 12; 17 18; 27 1
W Carinæ	9 19.2	−55 32	7.5– 8.5	4 08 9	5 5; 9 14; 18 8; 27 2
S Antliæ*	27.9	−28 11	6.7– 7.8	0 07.8	3 11; 9 23; 22 22; 20 10
W Ursæ Maj.	9 36.7	+56 24	8.	0 04.0	2 4; 8 20; 22 5; 28 21
RR Leonis	10 02 1	+24 03	9.1–10.0	0 10.9	7 9; 14 3; 20 22; 27 17
ST Ursæ Maj.*	11 22.4	+45 44	6.7– 7.2	8 19.2	5 14; 14 10; 23 5
SU Draconis	11 32.2	+67 53	8.9– 9.6	0 15.8	3 1; 9 16; 22 21; 29 11
S Muscae	12 07.4	−69 36	6.5– 7.3	9 15.8	4 19; 14 11; 24 3
SW Draconis	12.8	+70 04	8.8– 9.6	0 13.7	5 11; 11 4; 22 13; 28 6
T Crucis	15.9	−61 44	6.8– 7.6	6 17.6	3 21; 10 14; 24 1; 30 19
R Crucis	18.1	−61 04	6.8– 8.0	5 19.8	2 17; 8 12; 20 4; 31 20
S Crucis	48.4	−57 53	6.6– 7.8	4 16 6	3 6; 7 23; 17 8; 26 17
RZ Centauri	12 55.6	−64 05	8.5– 8.9	0 22.5	6 16; 14 4; 21 16; 29 5
W Virginis	13 20.9	− 2 52	9.0–10.0	17 06.5	17 20
RV Urs. Maj.	13 29.4	+54 31	9 2– 9.9	0 11.2	6 1; 13 1; 20 2; 27 2
ST Virginis	14 22.5	− 0 27	10.3–11.4	0 09.9	7 3; 15 8; 23 13; 31 18
V Centauri	25.4	−56 27	6.7– 7.6	5 11.9	2 8; 7 20; 18 19; 29 19
RS Bootis	29.3	+32 11	8.9–10.	0 09.1	8 5; 15 18; 23 7; 30 20
RU Bootis	14 41.5	+23 44	12.8–14.3	0 11.9	4 3; 11 13; 18 23; 26 9
R Triang. Austr	15 10.8	−66 08	6.7– 7.7	3 09.3	2 15; 9 10; 22 23; 29 18
S Triang. Austr	15 52.2	−63 29	6.5– 7.5	6 07.8	3 11; 9 18; 22 10; 28 18
S Normæ	16 10.6	−57 39	6.5– 7.4	9 18.1	2 22; 12 16; 22 10
RW Draconis	33.7	+58 03	9.6–10.8	0 10.6	9 0; 17 20; 26 17
RV Scorpii	16 51.8	−33 27	6.8– 7.6	6 01.5	5 10; 11 12; 17 13; 29 16
u Herculis*	17 13.6	+33 12	5.1– 5.6	2 01 2	3 2; 9 6; 21 13; 27 17
RV Ophiuchi*	17 29.8	+ 7 19	9.–< 11	3 16.5	1 21; 9 6; 24 0; 31 9
X Sagittarii	41.3	−27 48	4.0– 6.0	7 00.3	1 21; 8 22; 22 22; 29 22
Y Ophiuchi	47.3	− 6 07	6.2– 7.0	17 02.9	17 5
W Sagittarii	17 58.6	−29 35	4.8– 5.8	7 14.3	2 20; 10 10; 18 1; 25 15
Y Sagittarii	18 15.5	−18 54	5.8– 6.6	5 18.6	4 15; 10 10; 21 23; 27 17
U Sagittarii	26.0	−19 12	7.0– 8.3	6 17.9	7 2; 13 20; 20 14; 27 8
Y Scuti	32.6	− 8 27	8.7– 9.2	10 08.3	5 3; 15 11; 25 20
Y Lyrae	34.2	+43 52	10.5–12.	0 12.1	4 14; 10 15; 22 16; 28 17
RZ Lyrae	39.9	+32 42	9.9–11.2	0 12.3	1 16; 6 18; 17 0; 27 5
RT Scuti	44.1	−10 30	9.1– 9.7	0 11.9	4 9; 9 8; 19 6; 29 4
β Lyrae *	46.4	+33 15	3.4– 4.5	12 21.8	9 20; 22 18
κ Pavonis	18 46.9	−67 22	4.0– 5.5	9 02.2	1 20; 10 22; 20 0; 29 3
U Aquilae	19 24.0	− 7 15	6.4– 7.1	7 00.6	6 21; 13 21; 20 22; 27 22
XZ Cygni	30.4	+56 10	8.7– 9.3	0 11.2	2 6; 6 22; 16 5; 25 13
U Vulpec.	32.2	+20 07	6.9– 7 6	7 23.5	1 10; 9 9; 17 9; 25 9
SU Cygni	40 8	+29 01	6.6– 7.4	3 20.3	3 12; 11 5; 18 21; 26 14
η Aquilae	47.4	+ 0 45	3.5– 4.7	7 04.2	6 1; 13 5; 20 9; 27 14
S Sagittae	51.5	+16 22	5.6– 6.4	8 09 2	2 2; 10 11; 18 20; 27 6
X Vulpec.	19 53.3	+26 17	8.5– 9.1	6 07.7	1 22; 8 6; 20 21; 27 5
XX Cygni	20 01.3	+58 40	10.5–11.5	0 03.2	4 22; 11 16; 25 3; 31 21
V Vulpec. *	32.3	+26 15	8.0– 9.0	37 19 0	
X Cygni	20 39.5	+35 14	6.4– 7.7	16 09 3	6 16; 23 1

Maxima of Variable Stars of Short Period not of the Algol Type.

Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in December 1912.							
	h m	° ′		d h	d	h	d	h	d	h	d	h
T Vulpec.	19 47.2	+27 52	5.5— 6.5	4 10.5	3	19;	8	6;	16	3;	25	23
WZ Cygni *	49.3	+38 27	9.8—10.8	0 14.0	3	20;	9	17;	21	9;	27	5
WY Cygni	52.3	+30 03	9.5—10.3	0 13.5	5	9;	10	23;	22	4;	27	19
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	5	0;	9	12;	18	11;	22	22
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	15	11;	30	5				
VY Cygni	21 00.4	+39 34	8.9— 9.5	7 20.6	5	14;	13	10;	21	7;	29	3
VZ Cygni	21 47.7	+42 40	8.4— 9.2	4 20.7	4	17;	9	14;	19	7;	29	1
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.6	6	21;	15	22;	24	4		
δ Cephei	25.5	+57 54	3.7— 4.9	5 08.8	3	17;	9	2;	19	19;	30	13
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	11	10;	22	7				
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	6	3;	12	13;	25	10;	31	20
V Lacertae	44.5	+55 48	8.2— 8.9	4 23.6	4	2;	9	1;	19	1;	29	0
X Lacertae *	22 45.0	+55 54	8.2— 8.6	5 10.6	5	3;	10	14;	21	11;	26	22
SW Cassiop.	23 03.7	+58 12	9.2— 9.7	5 10.6	3	21;	9	8;	20	4;	25	15
RS Cassiop.	32.6	+61 52	9.1—10.0	6 07.1	7	5;	13	12;	19	19;	26	3
RY Cassiop.	47.2	+58 11	9.2—10.0	12 03.4	9	16;	21	20				
U Pegasi	23 52.9	+15 24	9.0— 9.7	0 04.5	4	13;	12	1;	19	13;	27	1

Confirmation of the Variability of Three New Variables.— These three stars have been observed with the equatorial Coudé (elbow telescope).

49.1911 Coronæ Borealis (BD +26° 2704). A discussion of 24 observations made between February 27 and July 23, 1912, shows that this star belongs to the β Lyræ type, and gives as provisional elements the following:

$$\text{Min.} = 2419488.02 \text{ (G.M.T.)} + 7^d.610 \text{ E.}$$

The limits of its brightness are approximately,

Principal Minimum	$9^m.5$
Secondary Minimum	9 .1
Maximum	8 .8

50.1911 Can. Ven. This star is of the δ Cephei type. The elements which I have derived from 33 observations made from February 16 to July 23, 1912, are:

$$\left.\begin{array}{l}\text{Max.} = 2419449.96\\ \text{Min.} = 2419449.27\end{array}\right\} + 1^d.890 \text{ E}$$
$$\text{M} - \text{m} = 0^d.69$$

The limits of brightness are about as follows: Maximum = $9^m.8$, Minimum = $10^m.5$.

UV Aurigæ. The brightness of this very red star has diminished constantly and regularly from magnitude 8.2 on Jan. 10, 1912 to magnitude 9.7 on May 10, 1912, or 1.5 magnitude in four months. It is very likely a star of a long or irregular period. M. Luizet, in *A. N.* No. 4601.

COMET AND ASTEROID NOTES.

Comet 1912 *a* (Gale.)— Gale's comet has come steadily north and became visible to observers in the southern part of the United States in the latter part of September. It is now between the foot of *Hercules* and the head of *Serpens*, and will pass through *Corona* during the next two weeks. The approximate course of the comet is shown on the diagram Fig. 1.

FIG. 1. THE COURSE OF COMET 1912 *a* (GALE) AMONG THE STARS DURING NOVEMBER.

The following elements, computed by Messrs. Crawford and Haynes of the Berkeley astronomical department and published in the *Lick Observatory Bulletin* No. 218, agree very closely with elements computed by C. J. Merfield of Melbourne (*A. N.* 4603).

ELEMENTS.

T = 1912, Oct. 4.95777 Gr. M. T.
ω = 25° 38′ 36″.7
Ω = 297 01 41 .7 } 1912.0
i = 79 47 28 .4
q = 0.716007

CONSTANTS FOR THE EQUATOR, 1912.0

$x = r\ [9.682212] \sin (\ 96^\circ\ 29'\ 07''.1 + v)$
$y = r\ [9.942907] \sin (274\ \ 23\ \ 41\ .7 + v)$
$z = r\ [9.999949] \sin (\ \ 4\ \ 52\ \ 42\ .4 + v)$

Ephemeris of Comet 1912 *a*.

[From Astronomische Nachrichten 4603.]

	R. A.			Decl.		log r	log Δ	Brightness
	h	m	s	°	′			m
Nov. 1	16	02	58	+24	38.7			
2		3	47	25	21.6	9.9605	0.0988	7.0
3		4	36	26	03.8			
4		5	24	26	45.8			
5	16	07	01	+28	08.3	9.9832	0.1052	7.2

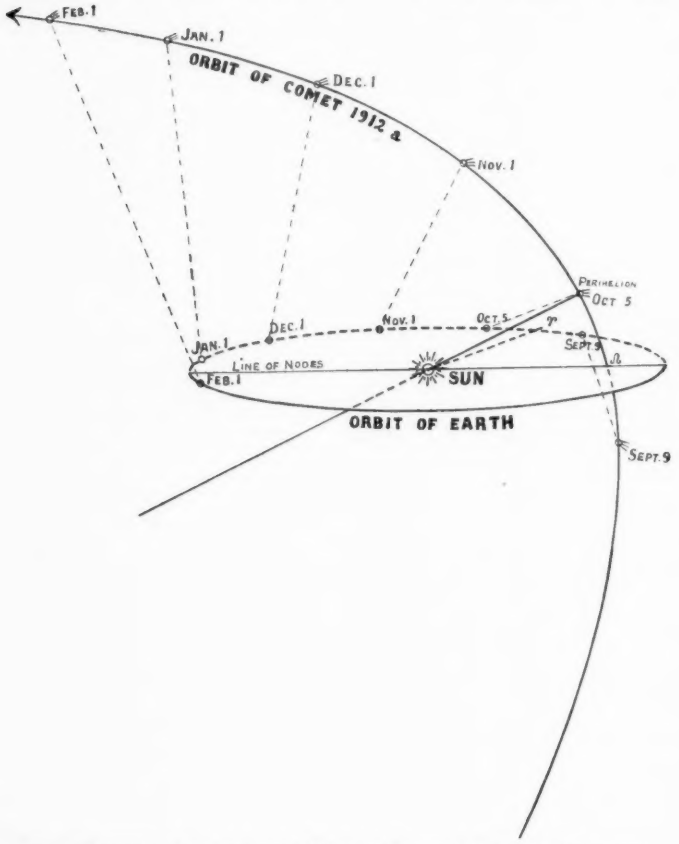


FIG. 2. DIAGRAM SHOWING THE ORBIT OF COMET 1912 *a* IN RELATION TO THAT OF THE EARTH.

The diagram Fig. 2 shows the orbit of the comet in relation to that of the earth. It is evident that the comet was nearest to the earth in September, passing almost perpendicularly through the plane of the earth's orbit about Sept. 22, and that it will remain visible in the northern heavens for some months. It will become gradually fainter because of its increasing distance both from the sun and the earth.

Although some observers have reported the comet as visible to the naked eye, to most of us, because of its low altitude in the southwest, it has been visible only with the aid of a telescope. It has a stellar nucleus, a bright coma or head of 5′ or 6′ diameter, and a faint slender tail of two or three degrees length.

Ephemeris of Gale's Comet 1912 *a*.

1912	α h	m	s	δ °	′	″	log *r*	log Δ
Nov. 2	16	4	54	+23	59	0	9.96515	0.11332
6	16	8	30	26	42	40	9.98723	0.11977
10	16	12	9	29	21	10	0.00933	0.12498
14	16	15	58	31	58	57	0.03111	0.12894
18	16	19	53	+34	31	37	0.05245	0.13230

$x = r\,[9.64834]\,\sin(\ 73^\circ\ 49'\ 8''.80 + v)$
$y = r\,[9.95257]\,\sin(247\ \ 41\ \ 0\ \ + v)$
$z = r\,[9.99957]\,\sin(338\ \ 53\ \ 2\ .1\ + v)$

The above figures are based upon Ebell's elements.

F. E. Seagrave.

Providence, R. I., Oct. 4, 1912.

Spectrum of Gale's Comet.—Photographs of the spectrum were taken at the Yerkes Observatory with the objective prism of 15° angle in connection with the Zeiss UV camera of 14.5 cm aperture and 81.4 cm focal length. The scale is small, only 3.0 mm from *Hβ* to *Hθ*, so that only the bolder features of the spectrum were visible, but with the advantage that these could be photographed with the short exposures which the low position of the comet made necessary.

The plates so far taken are as follows:—

1912 Sept. 30, 6h 49m to 7h 19m C. S. T.
Oct. 1, 6 45 " 7 20 "
14, 6 26 " 7 11 "

On the first two plates, taken with the comet near the horizon, the carbon band at wave-length 4711 and the cyanogen band at a wave-length 3883, were the prominent features. But little continuous spectrum was visible. The third plate, with the comet in more favorable position, showed these two bands much stronger, the cyanogen band stronger than the carbon; the continuous spectrum quite strong, with local strengthening near the green carbon band and near wave-length 4000.

This may perhaps be called a normal comet spectrum, as it closely resembles the spectra of Halley's comet before perihelion, Comet a 1910, and the comets of Kiess, Beljawsky and Brooks of 1911.

On the plate of Oct. 14 the spectrum of the tail can be faintly seen, but no details recognized.

J. A. Parkhurst.

Oct. 21, 1912.

Gale's Comet, was picked up with the 10-inch refractor at this observatory on September 27, after quite a long period of cloudy and rainy weather. The comet's position at 7 o'clock, Standard time was 15h 7m 30s decl. south 10° 50′. The comet was fairly bright in the 10-inch telescope, notwithstanding the bright twilight and nearly full moonlight, with marked central condensation, and a short, extremely faint tail. It was an easy object in the 3-inch finder, but at no time was it visible to the naked eye from this observatory. On October 2 its position was 15h 21m 40s,— 4° 20′; on October 4 15h 26m 10s,—1° 36′; and on both of these occasions the comet appeared much brighter because of the darker sky, and the tail was traced to 2° in length. On October 5 in R. A. 15h 28m 30s;—0° 35′ the comet was not so bright, but the nucleus was almost stellar and the tail easily seen both in the larger telescope and finder.

WILLIAM R. BROOKS.

Smith Observatory,
Geneva, N. Y., October 14, 1912.

Tuttle's Periodic Comet.—In *A. N.* 4602 Kaplan Niko Milicevic gives a search ephemeris for Tuttle's periodic comet, which is due at perihelion early in January 1913, after an absence of 13⅔ years. The comet was faint in 1899 because of its distance from the earth. This year in December it will pass comparatively near the earth so that it ought to be easily found. The ephemeris, however, is quite uncertain, since the elements have not been corrected for perturbations since 1899. The following is the portion of the ephemeris for November and December:

Berlin Noon	R. A. h m s	Dec. ° ′	log *r*	log Δ
Nov. 5	10 18 05	+68 44.3	0.1295	9.9097
10	25 08	66 47.2	0.1147	9.8590
15	29 33	64 26.3	0.1000	9.8009
20	31 17	61 27.0	0.0855	9.7337
25	30 11	57 24.8	0.0716	9.6546
30	26 00	51 31.4	0.0583	9.5601
Dec. 5	18 19	42 07.0	0.0460	9.4474
10	10 06 31	+25 46.6	0.0349	9.3223
15	9 49 50	— 1 40.1	0.0254	9.2321
20	9 27 16	33 21.7	0.0178	9.2625
25	8 57 38	54 59.2	0.0123	9.3771
30	8 19 45	66 49.7	0.0091	9.4959
Jan. 4	7 33 24	−73 15.5	0.0083	9.5969

It appears from this that the comet will move across the sky very rapidly during December, the declination changing from 50° north to 68° south in that month. At its nearest approach, if the calculations are correct, the comet will be about 17,000,000 miles from the earth.

New Comet 1912 *b* (Schaumasse-Brooks).—A cablegram from Kiel received at Harvard College Observatory Oct. 20 announced the discovery of the second comet of the year by Schaumasse, at Nice, on October 18. Its position was in the constellation Sextans, about 10° south and a little west of the first magnitude star Regulus. Its motion since then has been toward the southeast, about a degree and a half a day. The comet is rather faint although easily seen with a small telescope. It is about 3° in diameter and has a strong central condensation but only a faint trace of a tail. The following are all the observations which have come to hand:

Greenwich M.T.	R.A. h m s	Decl. ° ′ ″	Observer	Place
Oct. 18.6915	9 57 36	+1 36	Schaumasse	Nice
21	10 03 20	−1 08	Brooks	Geneva
21.0392	10 04 10.4	−1 13 17	Aitken	Lick
22.9479	10 09 32.3	−3 32 20	Wilson	Northfield

As will appear from the communication given below the comet was discovered independently by Professor Brooks at Geneva, New York, on the morning of Oct. 21, a few hours before he received the announcement of the discovery by Schaumasse.

A later cablegram from Kiel (Oct. 22) states that Fayet and Schaumasse announce that the elements of Schaumasse's comet are nearly identical with those of Tuttle's comet. If this is really Tuttle's comet, it is coming to perihelion about two months ahead of the time calculated for it. (See note above).

Tuttle's comet was discovered on January 4, 1858, at the Harvard College Observatory by Horace P. Tuttle. It was soon shown to be identical with Méchains Comet 1790 II. Its period is about 14 years. It was observed in 1871, 1885 and 1899.

Independent Discovery of Comet 1912 *b* (Schaumasse-Brooks.) While sweeping the eastern heavens this morning I discovered comet in right ascension 10 hours 3 minutes 20 seconds; declination south 1 degree 8′. Motion slowly eastward. The comet is a fairly bright telescopic object, with slight central condensation and was visible in the 3-inch finder.

WILLIAM R. BROOKS.

Since the above was mailed a telegram from Harvard, in response to my telegram of announcement states that the comet had been discovered by Schaumasse, time not given. My telegram announcing my discovery of the comet was sent at 6 o'clock this morning, the Harvard telegram was received this afternoon.

WILLIAM R. BROOKS.

Smith Observatory,
Geneva, N. Y., Oct. 21, 1912.

Eros in 1914.—As Eros is an unusually interesting asteroid I have just finished an ephemeris for the opposition of 1914 based upon elements brought up to the present time.

EPHEMERIS OF EROS FOR THE OPPOSITION OF 1914.

Gr. Midnight 1914	α h m s	δ ° ′ ″	log *r*	log Δ
Sept. 15	23 48 42	+24 5 26	0.19810	9.78992
19	23 41 17	+24 24 9	0.19506	9.77899
23	23 23 33	+24 33 40	0.19190	9.76995
27	23 25 40	+24 33 11	0.18870	9.76301
Oct. 1	23 17 55	+24 23 22	0.18540	9.75813
5	23 10 31	+24 5 55	0.18202	9.75531
9	23 3 43	+23 40 0	0.17858	9.75457
13	22 57 37	+23 8 37	0.17504	9.75565
17	22 53 7	+22 31 59	0.17142	9 75843
21	22 48 17	+21 52 42	0.16776	9.76279
25	22 45 12	+21 12 33	0.16400	9.76834
29	22 43 11	+20 31 31	0.16020	9.77506

F. E. SEAGRAVE.

Schaumasse's Comet.—This morning the comet was seen and photographed with the Bruce telescope. The photographs (35^{m} exposure) show only a small hazy spot, with no tail.

The comet could not be seen in moonlight with the 5 in. guiding telescope, and on a moonless sky, between the setting of the moon and dawn, it was only a small round hazy spot with no definite condensation. It was of about the tenth magnitude and rather dim.

E. E. BARNARD.

Yerkes Observatory, October 24, 1912.

COMMUNICATIONS QUESTIONS AND ANSWERS.

Conjunction of Lutetia with Jupiter.—On the night of June 6 while observing with my 6″ refractor I witnessed the conjunction of the asteroid Lutetia with Jupiter's satellites. According to my observations the conjunction tion with Satellite III took place three hours later than predicted. I also observed the asteroid June 7, at 9h and June 8 at 9h.

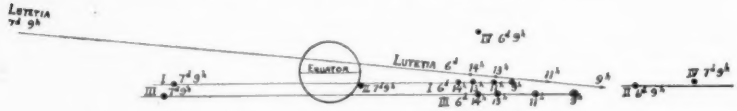


DIAGRAM OF THE CONJUNCTION OF LUTETIA (21) WITH JUPITER.
June 5th. 1912. C. S. T.

The accompanying diagram shows the approximate positions of the asteroid and satellites during the time of observation, also the probable path traversed by Lutetia and the apparent paths traversed by satellites III and I between June 6 at 9h, and June 7 at 9h, 1912, C.S.T.

J. J. SCHAFER.

The Comet Discovered by Gale at Sydney on the 8th of September has been observed here, by me, on September 25, 27. 28, 29, and 30. On the 25th it was bright moonlight and all that was seen was a round fuzzy ball about two or three times the apparent diameter of Jupiter. I estimated the magnitude about 5.0 but it might have been fainter. The position of the comet was approximately R. A. 15^{h}, Dec. —13½°. On the 27th the aspect was very much the same. On the 28th the Nucleus was very well defined and much brighter. The tail was very distinct and at a position angle of about 93°. It was about ½° long. On the 29th the tail seemed more distinct but the aspect was very much the same. On the 30th the comet was observed through a break in the clouds and a very satisfactory observation could not be obtained, but it seemed very much brighter and the tail much more distinct. On the 28th the comet was about ½° from Beta Librae and the two objects were in the same field.

On Oct. 6th the comet was visible to the naked eye and equal to a 4.5 magnitude star, the tail was about ½° long and at a position angle of 87°.

ALAN P. C. CRAIG.

Gale's Comet.—I wish to report that I had a magnificent view of Comet (*a*) 1912 (Gale) on Oct. 10, at 8 p. m.

The comet was visible to the naked eye after I had located its exact position. Its position at this observation was approximately, Right Ascension 15^h 40^m and North Declination 5° 30′. It showed a tail about 1° in length which extended to the south-west. My aperture was two inches. This size telescope brings it out beautifully.

W. H. CASSELL, M. D.

Wytheville, Va., Oct. 11, 1912.

NOTES FOR OBSERVERS.

Report of the American Association of Variable Star Observers Sept.-Oct., 1912. Including the Annual Report.—The clear weather which has for the most part prevailed over the country during the past month has been well improved by our observers, and this report has broken all records for number of observations, and number of variables observed. Four observers have established new records also this month for number of monthly observations. Dr. Gray sent in the splendid total of 195 observations for his month's work, which does not represent it fully, as only *positive* observations are available for this report. Mr. Jacobs was a close second for the month with 162 observations, and leads in the grand total for the year with 1014 observations.

Mr. Craig, observing with a glass of only 2½″ aperture, sent in 100 observations this month. This shows what can be done in this line of observational work with a modest telescopic equipment if the observer properly applies himself. Mr. Craig deserves a great deal of credit for the excellent work he has done in observing variables in a short time.

Mr Frederick C. Leonard, of Chicago, Ill., has joined the Association during the past month. In this and future reports his observations will be indicated by the abbreviation "Le".

The variables 194632 Chi Cygni, 154428 R Cor. Bor., and 213843 SS Cygni, have been especially well observed of late. The former has remained bright and fairly steady, rising about half a magnitude during the month. R Cor.Bor. has fluctuated narrowly, close to the 6th magnitude. The variable 210868 T Cephei has been closely observed, rising approximately from 6.5 to 6.0 magnitude during the month.

Mr. Jacob's obervations of the rise of the variable 013338 Y Andromedae, a magnitude in a week, is of interest.

Hartwig calculated a maximum (7.7) of the variable 141954 S Boötis for Aug. 29th. On approximately that date the observations show that the variable was close to the tenth magnitude, as was the variable 160625 RU Herculis Sept. 22, for which Hartwig calculated a maximum (7.0) on that date.

Dr. Gray observed a maximum (8.0) of the variable 213553 RU Cygni about the third week in Sept. This was fairly close to Hartwig's calculated maximum for this variable, for Oct. 1.

The variable 213843 SS Cygni rose on the third of Oct. after a 68 day period of dimness, and the sudden increase in brilliance of this mysterious sun was witnessed by a number of our observers with observations well in accord. Mr Jacobs' observations of this star are most interesting. He estimated the

VARIABLE STAR OBSERVATIONS Sept.–Oct., 1912.

001726
T Androm.

Mo.	Day	Est.	Obs
9	4	8.3	G
	6	9.2	O
	9	8.4	G
	9	9.1	O
	12	9.1	O
	13	9.1	Y
	16	8.2	G
	17	8.7	S
	18	8.2	G
	22	8.7	O
	28	8.9	Y
	29	8.2	G
10	1	8.4	O
	3	8.6	S
	4	8.8	Y
	5	8.6	O
	8	8.4	O

001755
T Cassiopeiae

9	4	8.4	C
	6	8.2	C
	6	7.7	B
	8	8.6	O
	10	8.8	J
	11	8.0	G
	12	7.9	O
	12	7.9	S
	13	8.0	B
	13	8.4	C
	15	8.4	L
	16	8.9	Ha
	16	7.8	Y
	16	8.4	Bu
	17	8.7	J
	20	8.7	J
	21	8.8	Bu
	22	8.1	G
	27	8.2	G
	27	7.9	B
	28	7.9	Y
	30	8.5	Bu
10	1	8.6	O
	1	8.7	J
	4	8.5	S
	5	7.9	Y
	5	7.9	B
	6	8.8	J
	6	8.9	Ha
	7	8.8	J

001838
R Androm.

9	16	11.0	Hu
10	4	11.6	Hu

004047
U Cassiopeiae

9	16	9.3	Y
	17	8.8	G
	28	9.0	Y
	29	8.5	G

U Cassiopeiae

Mo.	Day	Est.	Obs
10	1	8.3	G
	3	8.6	S
	5	8.4	O
	5	8.9	Y
	6	8.4	O

004132
RW Androm.

9	17	14.2	J

004533
RR Androm.

10	4	12.6	Hu

004958
W Cassiopeiae

9	8	12.3	J
	17	11.9	J
	20	12.3	J
10	1	11.9	J
	5	11.9	J
	7	11.8	J

011208
S Piscium

9	8	9.6	O
10	1	10.3	Y
	5	10.0	O

013238
RU Androm.

9	8	11.8	J
	10	11.8	J
	17	12.0	J
	20	12.0	J
10	1	12.6	J

013338
Y Androm.

9	8	11.2	J
	10	11.1	J
	17	9.9	J
	20	9.7	J
	30	9.6	J
10	1	9.7	J
	6	10.0	J
	7	9.7	J

014958
X Cassiopeiae

9	7	11.2	L
	16	11.0	L
	16	9.7	Y
	28	9.7	Y
10	5	9.8	Y

021024
R Arietis

9	8	8.5	O
	9	9.0	G
	12	8.2	O
	19	8.2	G
	21	8.8	C
10	2	9.2	G
	3	9.2	O
	5	9.3	O

021143 a
W Androm.

Mo.	Day	Est.	Obs
9	11	9.6	G
	18	10.0	G

021258 a
T Persei

9	4	9.2	C
	6	8.9	C
	10	8.9	C
	13	9.1	C
	17	9.1	B
10	5	8.7	B

021403
o Ceti

8	30	6.7	L
9	5	6 8	F
	7	6.7	L
	9	7 0	C
	10	6.5	G
	12	7.3	C
	13	7.1	L
	16	7.3	C
	17	6.7	G
	18	7.3	L
	20	7.0	G
	21	7.4	C
	23	7.5	L
	30	7.0	Bu
10	2	7.0	Bu
	2	7.3	G
	4	7.5	Hu
	5	7.5	Ha
	5	7.2	Bu

021558
S Persei

9	13	9.7	G
	17	9.3	B
	27	8.8	B
10	5	8.9	B

022150
RR Persei

9	16	13.0	Y
10	4	13.0	Y

022813
U Ceti

9	9	8.5	C
	12	8.5	C
	16	8.7	C
	21	8 9	C

023133
R Trianguli

9	10	10.2	G
	27	9.0	Y
10	4	9.5	Y

024356
W Persei

9	9	9.9	O
	11	9.2	Hu
	12	10.2	G

W Persei

Mo.	Day	Est.	Obs
10	2	10.2	G
	4	9.2	Hu
	6	9.9	O

032043
Y Persei

9	17	9.8	Hu
	29	9.0	G
10	2	9.8	G
	5	9.8	O

032335
R Persei

9	16	12.5	Y
10	4	11.8	Y

035124
T Eridani

9	20	8.4	G

035916
V Eridani

9	17	8.6	G

042215
W Tauri

9	21	10 5	G
10	4	11.3	Y

043065
T Camelop.

9	16	12.5	Y

043274
X Camelop.

9	8	8.8	O
	16	8.0	O
10	1	7.8	O
	5	8.0	O

045514
R Leporis

9	9	9.0	C
	10	8.6	G
	12	9.3	C
	14	9.1	L
	16	9.3	C
	17	8.6	G
	20	8.7	G
	21	9.3	C
10	2	8.7	G

050953
R Aurigae

9	8	9.1	J
	9	8.8	C
	10	9.1	J
	16	8.8	Y
	17	9.2	J
	20	8.9	J
	25	8.5	B
	28	8.2	Y
10	1	8.7	J
	2	8.2	B
	5	8.5	J
	5	8.2	Y
	7	8.5	J
	7	8.1	B

054920
U Orionis

Mo.	Day	Est.	Obs
9	9	8.9	C
	12	8.8	C
	16	9.0	C
	17	8.3	G
	21	9.1	C

052034
S Aurigae

9	18	10.2	L
10	5	9.3	Y

053068
S Camelop.

9	16	9.9	Y
	28	9.5	Y
10	5	9 1	Y

053531
U Aurigae

10	4	11.0	Y

054319
SU Tauri

10	4	11.0	Y

055353
Z Aurigae

9	16	10.7	Y
10	4	10.6	Y

060547
SS Aurigae

10	4	10.8	Y
	5	10.9	Y

073508
U Can. Min.

9	7	8.8	L
	16	8.5	L
	24	8.5	L

081112
R Cancri

9	9	8.6	C
	12	8.6	C
	21	8.8	C

093178
Y Draconis

10	4	11.8	Y

101272
S Cassiop.

10	5	12.7	B

103769
R Urs. Maj.

8	28	8.7	L
9	1	8.5	L
	3	8.2	F
	3	8.2	L
	5	7.9	L
	6	7.9	B
	6	8.1	F
	7	7.6	L
	8	7.9	J
	8	7.8	M
	8	8.0	Ha
	9	7.9	B
	10	7.8	J

VARIABLE STAR OBSERVATIONS Sept.–Oct. 1912.—Con.

R Urs. Maj.

Mo.	Day	Est.	Obs.
9	10	7.6	Bu
	11	8.2	G
	12	8.0	C
	13	7.7	L
	14	8.0	F
	14	7.6	L
	15	7.8	L
	16	7.9	L
	16	7.7	Ha
	16	7.7	B
	16	7.9	G
	16	7.9	C
	17	7.6	J
	18	7.8	L
	21	7.4	Bu
	21	7.9	C
	21	7.7	L
	23	7.7	G
	24	7.9	L
	25	7.6	B
	25	7.7	Y
	27	7.9	J
	28	7.6	G
	29	7.8	Ha
	30	8.2	S
	30	7.6	Bu
10	2	7.7	B
	5	7.9	Ha
	5	7.8	Y
	7	8.0	B

123160

T Urs. Maj.

10	5	12.2	Y

123961

S Urs. Maj.

9	6	11.7	B
	8	11.3	J
	10	12.0	B
	10	11.4	J
	12	11.2	G
10	1	11.8	J
	5	11.9	Y
	5	12.5	M
	5	12.0	B

134440

R Can. Ven.

8	28	9.0	L
9	1	9.1	C
	4	8.8	G
	4	9.5	C
	5	9.4	L
	6	9.4	C
	9	9.0	G
	10	9.5	C
	12	9.2	G
	13	9.8	C
	16	9.4	G
	17	9.5	G
	18	9.6	L

141567

U Urs. Min.

Mo.	Day	Est.	Obs.
9	8	10.5	J
	9	10.8	S
	10	10.8	J
	17	10.9	J
10	1	11.1	J

141954

S Boötis

9	8	9.8	O
	9	9.6	B
	9	9.9	J
	10	9.9	J
	12	9.7	O
	16	9.7	O
	16	9.5	B
	17	9.8	J
	20	9.3	G
	27	9.9	J
	28	9.4	O
10	1	9.5	J
	4	9.4	B
	5	9.3	J

142539

V Boötis

8	28	10.9	L
9	3	10.5	L
	5	9.9	L
	9	10.1	B
	9	9.8	V
	11	9.9	G
	12	9.9	S
	14	9.8	L
	16	9.5	L
	16	10.3	B
	17	9.2	G
	18	9.1	L
	20	9.0	G
	23	8.8	G
	27	8.6	B
	28	8.6	G
	29	8.9	V
	30	8.5	G
10	1	8.5	G
	4	8.0	B
	5	8.9	V

142584

R Camelop

8	29	8.8	L
9	4	8.6	C
	5	8.9	L
	6	8.3	B
	6	8.2	C
	6	8.4	O
	8	8.6	J
	8	8.8	L
	9	8.4	G
	9	8.4	O
	10	8.7	J
	10	8.5	Bu
	10	8.4	B

R Camelop.

Mo.	Day	Est.	Obs.
9	12	8.4	O
	12	8.5	Bu
	13	8.4	G
	13	8.6	C
	15	8.8	L
	16	8.5	Bu
	16	8.7	O
	16	8.7	G
	17	8.7	J
	17	8.8	O
	17	8.5	B
	20	8.6	G
	20	8.8	J
	21	8.6	C
	21	8.0	Bu
	22	8.7	O
	23	8.4	Bu
	25	9.0	O
	25	8.4	B
	27	8.8	J
	28	9.0	O
	29	8.6	G
	30	8.5	Bu
10	1	9.0	O
	1	8.9	J
	2	8.4	Bu
	2	8.8	B
	5	9.2	J
	5	9.1	O
	7	8.7	B
	7	8.9	J
	8	9.3	O

143227

R Boötis

9	5	10.0	L
	9	9.5	O
	9	9.4	B
	12	9.5	O
	15	9.1	L
	16	9.4	O
	16	9.0	B
	17	9.1	L
	20	10.0	G
	27	8.5	B
10	4	8.0	B

151731

S Cor. Bor.

9	8	10.5	O
	12	10.3	O
	16	10.0	O
	28	10.8	O

153378

S Urs. Min.

9	3	9.4	L
	8	9.4	L
	28	8.6	G

154428

R Cor. Bor.

8	28	6.4	L
	29	6.4	L
	30	6.4	L

R Cor. Bor.

Mo.	Day	Est.	Obs.
9	1	6.3	C
	3	6.4	L
	3	6.2	F
	4	6.0	S
	4	6.2	C
	4	6.8	G
	5	6.3	L
	6	6.1	F
	6	6.0	C
	6	6.5	O
	7	6.4	L
	8	6.5	Ha
	8	6.1	M
	8	6.1	O
	8	7.0	G
	9	6.2	O
	9	6.2	S
	9	6.3	J
10	5.7	F	
	10	6.0	C
	10	6.0	J
	11	7.0	G
	12	6.4	S
	12	6.1	O
	12	6.2	Bu
	13	5.9	C
	14	6.0	F
	14	7.1	G
	14	6.3	L
	15	6.3	L
	16	6.3	L
	16	6.2	O
	17	6.9	G
	17	6.4	J
	17	6.2	O
	18	6.2	L
	19	6.2	G
	19	6.3	J
	20	6.6	G
	21	6.6	Bu
	21	6.6	G
	21	6.2	L
	22	6.2	O
	22	6.7	G
	24	6.2	G
	25	6.2	O
	27	6.0	G
	27	6.1	J
	28	6.1	O
	29	6.3	Ha
	29	6.2	G
10	1	6.1	J
	1	6.2	O
	1	6.6	G
	2	6.2	O
	5	6.2	O
	5	6.1	J
	5	6.5	Ha
	6	6.0	O

154536

X Cor. Bor.

Mo.	Day	Est.	Obs.
9	8	11.0	J
	10	11.0	J
	17	10.6	J
10	1	11.9	J

154615

R Serpentis

9	1	9.4	C
	4	9.7	C
	6	9.8	C
	9	8.6	G
	9	9.9	O
	10	10.2	C
	12	9.8	O
	13	10.2	C

155823

RZ Scorpii

9	3	8.6	G

155847

X Herculis

8	30	5.9	L
9	15	6.2	L

160625

RU Herculis

9	8	9.4	O
	12	9.2	O
	16	9.6	O
	22	10.0	O
	28	10.5	O
10	1	10.2	O
	5	10.2	O

162112

V Ophiuchi

9	11	10.5	G

162119

U Herculis

9	13	11.2	B
10	5	11.6	Y
	7	12.0	B

163137

W Herculis

9	17	11.8	Y
10	5	12.2	Y

163172

R Urs. Min.

9	8	9.4	O
	9	9.0	B
	10	9.2	Bu
	12	9.4	O
	16	9.0	Bu
	21	9.2	Bu
	22	9.6	O
	26	9.6	O
	28	9.0	B
10	1	9.6	O
	4	9.2	B
	6	9.6	O

VARIABLE STAR OBSERVATIONS to Sept.-Oct., 1912.—Con.

163266
R Draconis

Mo.	Day	Est.	Obs.
9	9 11.8		B
	17 11 5		J
10	1 11.1		J
	2 11.2		B
	4 11.0		Y
	5 11.1		J
	7 10.8		J

164715
S Herculis

9	9 10.5		O
	9 10.7		J
	10 10.6		J
	17 10.2		J
	19 10.0		J
	27 9.6		J
10	1 9.3		J
	2 9.4		O
	5 9.0		J
	6 9.2		O

165030
RR Scorpii

9	12 10.5		G

165631
RV Herculis

9	6 10.5		O
	16 9.8		O
	25 9.7		O
10	1 9.8		O
	5 9.8		O

170215
R Ophiuchi

9	11 11.0		G

171401
Z Ophiuchi

9	9 9.0		O

175458
T Draconis

9	4 9.7		G
	17 10.5		G
	30 10.5		V

180531
T Herculis

9	4 10.5		C
	5 11.9		L
	6 10.6		C
	7 11.4		B
	10 10.0		C
	17 10.0		S
10	2 10.1		S
	5 12.8		M
	5 10.6		O

181136
W Lyrae

9	28 10.7		Y
10	1 10.7		O
	4 9.6		Y
	5 9.7		O
	8 9.7		O

184205
R Scuti

Mo.	Day	Est.	Obs.
8	28 5.3		L
	30 5.4		L
9	1 5.6		C
	1 5.2		L
	3 5.5		F
	3 5.2		L
	4 5.7		C
	4 6.5		Bu
	5 5.3		L
	6 5.7		C
	7 5.2		L
	8 5.7		Ha
	8 5.0		M
	8 6.1		G
	9 5.1		B
	10 5.1		O
	10 5.5		C
	10 6.0		Bu
	12 6.1		G
	13 5.6		C
	14 5.7		F
	15 5.6		L
	16 5.2		L
	18 5.3		L
	19 5.8		M
	21 5.6		Bu
	22 6.0		G
	29 5.3		Ha
	30 5.8		M
10	1 6.1		G
	5 5.7		Ha
	6 5.6		M

191119
R Sagittarii

9	4 10.0		G

191319
S Sagittarii

9	4 11.0		G
	6 9.5		F

193449
R Cygni

10	5 12.2		M

193732
TT Cygni

9	8 8.0		C
	10 8.0		C
	13 8.1		C
	16 8.2		C
10	6 8.4		O

194048
RT Cygni

8	28 8.2		L
	30 8.0		L
9	1 7.9		C
	3 8.0		F
	4 7.8		C
	4 8.1		G
	6 7.7		C

RT Cygni

Mo.	Day	Est.	Obs.
9	6 7.7		M
	7 8.1		L
	8 7.7		C
	9 8.0		Hu
	10 8.3		G
	10 8.2		G
	10 7.7		C
	12 8.2		S
	13 7.7		C
	14 8.0		F
	16 8.1		G
	16 7.7		C
	16 8.2		Bu
	17 8.1		G
	17 8.3		S
	18 8.2		L
	19 8.0		Bu
	24 8.1		G
	29 8.1		G
	30 8.0		Bu
10	1 8.2		G
	2 8.2		G
	2 8.4		Bu
	3 8 5		O
	3 8.4		M
	4 8.7		S
	6 8.4		M

194348
TU Cygni

9	10 10.3		G
10	1 10.6		G
	3 9.6		M
	6 9.6		M

194632
χ Cygni

9	3 6.0		F
	5 6.0		F
	6 5.9		F
	6 5.5		O
	7 6.0		G
	7 5.7		C
	8 5.2		J
	8 5.5		C
	8 5.3		M
	8 5.4		O
	8 5.8		G
	8 5.3		Ha
	9 5.4		O
	9 5.7		G
	9 5.9		Hu
	9 4.7		B
	10 5.4		J
	10 5.6		F
	10 5.7		C
	10 5.7		G
	11 5.2		O
	11 5.6		G
	12 5.4		J
	12 5.1		O

χ Cygni

Mo.	Day	Est.	Obs.
9	12 5.6		G
	13 5.2		O
	13 5.1		G
	13 5.6		C
	14 5.4		F
	14 5.1		G
	16 5.5		Bu
	16 5.0		O
	16 5.2		C
	17 4.8		B
	17 5.1		O
	17 5.4		J
	17 5.3		J
	17 5.0		G
	17 5.6		Hu
	18 5.1		G
	19 5.1		M
	20 5.0		G
	20 5.5		J
	20 5.4		J
	21 5.7		Bu
	22 5.1		G
	22 5.1		O
	23 6.0		Bu
	23 5.1		G
	25 5.1		O
	25 4.9		G
	27 5.1		J
	28 4.4		B
	28 5.1		O
	28 5.0		Hu
	28 5.3		J
	29 5.2		J
	29 4 6		Ha
	30 6.0		Bu
	30 5.2		J
10	1 5.1		O
	1 5.2		J
	2 6.2		Bu
	2 5.3		J
	2 5.1		O
	2 5.0		G
	3 5.3		O
	4 4.8		B
	5 5.3		J
	5 5.2		O
	5 4.8		Ha
	5 6.2		Bu
	6 5.3		J
	6 5.1		O
	6 5.2		M
	7 5.4		J
	8 5.1		O

200647
SV Cygni

9	3 9.2		F
	4 9.2		C
	6 9.2		C
	9 9.0		C

SV Cygni

Mo.	Day	Est.	Obs.
9	16 9.2		G
	13 8.9		C
	14 9.2		F
	16 9.1		C
	17 8.9		Hu
	19 9.2		G
	23 9.3		G
	30 9.0		Bu

200715 a
S Aquilae

9	5 9.4		F
	30 10.2		G

200938
RS Cygni

9	3 7.2		F
	8 7.1		Ha
	8 8.0		J
	8 7.5		C
	8 7.1		G
	10 8.3		J
	13 7.8		C
	14 7.2		F
	17 7 4		J
	18 7.2		G
	20 7.6		J
	22 7.2		G
	27 7.6		J
	30 7.5		Bu

201647
U Cygni

9	3 9.3		G
	3 9.5		F
	8 10.2		J
	8 9.5		G
	10 10.0		J
	14 10.0		L
	14 9.8		G
	14 9.2		F
	17 9.9		J
	20 10.0		J
	22 10.0		G
	23 10.2		G
	27 10.2		J
	28 10.5		G
10	1 10.1		J
	1 10.5		G
	6 10.3		J
	7 10.3		J

202846
TV Cygni

8	30 9.5		L
9	3 9.6		L
	6 10.0		F
	18 9.8		L

VARIABLE STAR OBSERVATIONS Sept.-Oct. 1912.—Continued.

202946
SZ Cygni

Mo.	Day	Est.	Obs.
8	28	9.6	L
	30	9.4	L
9	3	9.5	L
	3	10.4	F
	4	9.7	C
	4	9.2	G
	5	9.6	L
	6	10.0	F
	6	9.8	C
	7	9.6	L
	8	9.7	G
	10	9.5	Bu
	10	9.8	G
	11	9.6	G
	13	9.2	G
	13	9.3	C
	14	8.4	F
	14	9.1	L
	16	9.2	C
	16	8.9	G
	16	9.5	Bu
	17	8.7	G
	17	9.4	Hu
	18	9.5	L
	18	9.2	G
	19	9.2	G
	20	9.4	G
	21	9.5	G
	22	9.6	G
	23	9.7	G
	24	9.8	G
	25	10.0	G
	28	8.8	G
	29	8.6	G
	30	8.7	G
	30	9.3	Bu
10	1	8.9	G
	2	9.2	G
	3	9.2	Hu

203816
S Delphini

Mo.	Day	Est.	Obs.
9	13	11.0	Y
10	4	10.9	Y

204016
T Delphini

Mo.	Day	Est.	Obs.
10	4	12.8	Y

204405
T Aquarii

Mo.	Day	Est.	Obs.
10	6	11.5	O

202846
RZ Cygni

Mo.	Day	Est.	Obs.
10	2	11.8	Y

205923
R Vulpeculae

Mo.	Day	Est.	Obs.
10	3	11.6	Hu

210116
RS Capricorni

Mo.	Day	Est.	Obs.
9	14	8.1	G
	29	8.0	G

210868
T Cephei

Mo.	Day	Est.	Obs.
8	28	6.6	L
	30	6.4	L
9	1	6.4	L
	3	6.5	L
	4	6.6	C
	6	6.6	C
	7	6.0	L
	8	6.5	Ha
	8	6.6	J
	8	6.4	O
	8	6.7	V
	9	6.0	B
	10	6.8	Bu
	10	6.5	J
	13	6.4	C
	13	6.0	L
	16	5.8	L
	16	6.0	Ha
	16	6.8	Bu
	16	6.5	V
	17	6.5	J
	17	6.0	O
	17	6.0	G
	18	6.0	L
	19	6.6	M
	20	5.9	J
	21	7.0	Bu
	22	6.0	O
	23	6.5	Bu
	23	5.7	G
	24	5.8	G
	24	6.2	L
	25	5.8	O
	27	5.8	J
	28	5.8	G
	28	5.8	O
	30	6.2	Bu
	30	6.3	V
10	1	6.1	J
	1	5.8	O
	2	6.3	S
	2	5.8	O
	2	6.5	Bu
	4	6.0	B
	5	5.9	O
	5	6.2	Ha
	5	6.7	Bu
	6	5.5	J
	6	6.0	O
	7	6.1	J
	8	6.0	O

213244
W Cygni

Mo.	Day	Est.	Obs.
9	3	6.7	L
	7	6.8	L
	10	6.7	G
	12	6.7	G
	13	6.9	L
	16	6.7	G
	18	6.1	L
	18	6.6	G
	23	6.6	G
	28	6.5	G
10	1	6.5	G

213678
S Cephei

Mo.	Day	Est.	Obs.
9	9	11.2	O
	9	9.9	B
10	4	11.1	B
	7	11.3	J

213753
RU Cygni

Mo.	Day	Est.	Obs.
9	17	8.0	G
	20	8.0	G
10	2	8.5	O

213843
SS Cygni

Mo.	Day	Est.	Obs.
9	6	12.0	L
	7	12.0	L
	8	11.9	J
	8	11.6	Hu
	9	11.6	Hu
	10	12.0	J
	11	11.6	Hu
	12	12.0	J
	13	11.6	Hu
	14	11.5	J
	16	12.0	L
	16	11.0	Hu
	17	11.8	L
	17	11.7	G
	17	11.6	Hu
	17	11.9	J
	20	12.2	J
	27	11.9	J
	28	11.6	Hu
	29	11.9	G
	29	11.9	J
	30	11.9	J
10	1	11.5	G
	1	12.0	J
	2	11.1	Y
	2	11.5	J
	3	8.9	O
	3	9.0	Hu
	3	8.7	S
	3	11.2	J
	3	8.8	J
	3	8.4	G
	4	8.3	G
	4	8.9	Y
	4	8.1	J
	4	8.2	O
	4	8.5	Hu
	4	8.1	S
	5	8.1	J
	5	8.7	Y
	5	8.2	O
	5	8.1	S
	5	8.4	Le
	6	8.3	Le

W Cygni

Mo.	Day	Est.	Obs.
9	18	6.6	G
	23	6.6	G
	28	6.5	G
10	1	6.5	G

213678
S Cephei

Mo.	Day	Est.	Obs.
	9	11.2	O
	9	9.9	B
	4	11.1	B
	7	11.3	J

213753
RU Cygni

Mo.	Day	Est.	Obs.
	17	8.0	G
	20	8.0	G
	2	8.5	O

213843
SS Cygni

Mo.	Day	Est.	Obs.
	6	12.0	L
	7	12.0	L
	8	11.9	J
	8	11.6	Hu
	9	11.6	Hu
	10	12.0	J
	11	11.6	Hu
	12	12.0	J
	13	11.6	Hu
	14	11.5	J
	16	12.0	L
	16	11.0	Hu
	17	11.8	L
	17	11.7	G
	17	11.6	Hu
	17	11.9	J
	20	12.2	J
	27	11.9	J
	28	11.6	Hu
	29	11.9	G
	29	11.9	J
	30	11.9	J
10	1	11.5	G
	1	12.0	J
	2	11.1	Y
	2	11.5	J
	3	8.9	O
	3	9.0	Hu
	3	8.7	S
	3	11.2	J
	3	8.8	J
	3	8.4	G
	4	8.3	G
	4	8.9	Y
	4	8.1	J
	4	8.2	O
	4	8.5	Hu
	4	8.1	S
	5	8.1	J
	5	8.7	Y
	5	8.2	O
	5	8.1	S
	5	8.4	Le
	6	8.3	Le

SS Cygni

Mo.	Day	Est.	Obs.
10	6	8.2	O
	6	8.1	J
	6	8.2	J
	7	8.5	Le
	7	8.3	J
	7	8.2	J
	8	8.3	O
	8	8.3	J

213937
RV Cygni

Mo.	Day	Est.	Obs.
9	1	8.2	C
	3	8.1	F
	4	8.2	C
	6	8.0	F
	6	8.2	C
	8	8.6	J
	10	7.8	G
	10	8.3	C
	10	8.4	J
	13	8.4	C
	14	7.6	F
	16	7.5	Hu
	16	7.5	G
	17	7.2	B
	17	8.5	G
	20	8.1	J
	23	7.8	G
	27	8.2	J
	28	7.5	Hu
	28	8.0	G
10	1	7.9	G
	1	8.2	J
	5	8.0	J
	7	8.4	J

222439
S Lacertae

Mo.	Day	Est.	Obs.
9	13	12.4	Y
	18	9.5	G

223841
R Lacertae

Mo.	Day	Est.	Obs.
9	13	9.7	Y

225120
S Aquarii

Mo.	Day	Est.	Obs.
10	3	10.7	Hu

230110
R Pegasi

Mo.	Day	Est.	Obs.
9	6	9.6	O
	9	9.8	O
10	1	9.0	O
	4	8.7	Y
	5	8.4	O
	8	8.4	O

230759
V Cassiopeiae

Mo.	Day	Est.	Obs.
9	3	8.0	F
	4	7.4	G
	6	7.5	O

V Cassiopeiae

Mo.	Day	Est.	Obs.
9	6	7.6	F
	8	7.4	G
	8	7.9	V
	8	7.6	J
	9	7.6	O
	10	7.7	J
	12	8.0	O
	14	7.8	F
	16	8.0	O
	16	7.9	V
	16	7.5	G
	17	7.8	J
	20	7.8	J
	22	8.1	O
	22	8.1	G
	23	8.2	G
	25	8.1	O
	27	8.0	J
	28	8.2	O
	29	8.2	G
	30	8.4	V
10	1	8.3	O
	1	8.6	G
	1	8.1	J
	5	8.6	O
	6	8.8	J
	7	9.1	J
	8	8.6	O

231425
W Pegasi

Mo.	Day	Est.	Obs.
9	8	8.4	V
	16	8.5	V
	30	8.5	V

233335
ST Androm.

Mo.	Day	Est.	Obs.
9	4	9.1	G
	6	9.3	O
	8	9.3	O
	8	9.4	G
	11	9.1	Hu
	12	9.3	O
	13	9.5	G
	16	9.2	O
	17	9.4	G
	22	9.3	O
	28	9.2	O
	29	9.8	G
10	1	9.2	O
	4	9.3	S
	4	8.8	Hu
	5	8.9	B
	5	9.3	O
	8	9.2	O

235350
R Cassiopeiae

Mo.	Day	Est.	Obs.
8	29	9.7	L
9	3	9.8	L
	4	9.4	G
	4	9.5	C
	6	9.3	C
	8	9.8	J

VARIABLE STAR OBSERVATIONS Sept-Oct. 1912—Continued.

R Cassiopeiae				R Cassiopeiae				R Cassiopeiae				Nova Gemin.				Nova Gemin.			
Mo	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs
9	8	9.6	V	9	16	10.0	V	10	1	10.4	O	8	30	7.3	L	9	20	8.0	G
	8	9.9	O		17	9.7	B		5	10.0	B	9	7	7.4	L		21	7.7	C
	9	9.2	B		17	9.8	J		235939				10	8.0	G		21	8.0	G
	10	9.7	J		18	9.9	G		SV Androm.				12	7.6	C		23	7.9	L
	12	9.9	O		27	10.5	J	10	4	12.5	Y		13	7.4	L		24	7.9	L
	13	9.6	C		30	10.2	V		Nova Gemin.				16	7.6	C	10	2	7.9	G
	15	10.1	L		30	11.0	G	8	28	7.3	L		17	7.6	G				

variable at 11.2 magnitude at 12:10 A. M. Oct. 3. At 7:15 P.M. the same day he made it 8.8, a rise of 2.4 magnitudes, and an increase of 9.2 times in brilliance in 19 hours, truly a wonderful performance. The variable apparently reached a maximum of 8.1 magnitude, or very close to it.

The association is indebted to Professor H. C. Wilson, the Editor of "Popular Astronomy", for publishing our reports, for his interest in the work, and for his efforts in establishing the organization.

Especial thanks are due Messrs Gray, Forsyth, and Bancroft, for the fine blue prints of the charts that they have distributed to observers whenever there has been a call for them.

It is also most gratifying to have associated with us the Directors of two Observatories. Prof. Anne S. Young, of Mt. Holyoke College, ond Miss Caroline E. Furness, of Vassar College, and her Assistant Miss Sutton.

Now that the clearing house has been in existence for a year and monthly reports published, I feel sure that the observers have come to realize its value. Through this opportunity for each observer to compare his work directly with that of others many mistakes of misidentification have been corrected, interest in the work has been stimulated, and variable star observing has been properly advertised as a highly interesting and practical line of observational work. But, perhaps, best of all we have come, through correspondence, to know each other better, and a fine spirit of comradeship born of a common interest has sprung up, which has, I think, been a source of pleasure to all concerned. An organization of this sort engaged in a pure labor of love cannot fail to benefit the individual members, apart from any value that may accrue to science through their combined efforts.

The annual report of observations and totals calls for comment. Surely it is a record to be proud of. From a monthly report of 206 observations contributed by seven observers it has reached a total of **1005** observations and eighteen observers.

Comparisons are odious but perhaps pardonable in this case. The last report of the V.S S. of the B.A.A., of twenty years standing, includes the observations of the section for five years 1905-1909 and shows a total of 14041 observations, the work of 25 observers on 21 variable stars. This is at the rate of 2800 observations a year. This, our first report, shows for one year's work a total of **6180** observations contributed by 17 observers of 175 variable stars, a most gratifying record to those interested in the welfare of the association.

In conclusion, if the service that has been rendered in compiling the reports has been acceptable to Professor Pickering, and the members of the association, then the labors of the secretary have been amply repaid.

William Tyler Olcott.
Corresponding Sec'y.

Norwich, Conn.
Oct. 10, 1912.

ANNUAL REPORT OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS FOR THE YEAR ENDING OCT. 10, 1912.

RECORD OF OBSERVATIONS.

	Bancroft	Burbeck	Bouton	Craig	Dow	Forsyth	Miss Furness	Gray	Hathorn	Hunter	Jacobs	Lacchini	McAteer	Olcott	Perkins	Miss Sutton	Miss Swartz	Vrooman	Miss Young	Additional Observations	Grand Total of Observations	Number of Observers	Variables Observed
1911																							
Oct.								2		6	51			65			8	11	63		206	7	69
Nov.								23		12	68	1		82			8	12	65		271	8	70
Dec.								36	10	14	66			96			7	9	36		274	8	73
Jan.			6			5		10	8	17	80	8		86			14	14	82		330	11	75
Feb.			18			13	18	51	18		69	56		53		16	13	24	58	4	411	13	83
Mar.			26			61	4	77	16	7	92	98	6	67		7	12	23	74		570	14	101
Apr.			18	3	9	50	16	95	30	10	65	148	14	66	5	31	3	33	43		639	17	97
May	18		22	18	15	9	11	113	20	14	109	61	36	104	4	19	18	26	64		681	18	91
June	53		28	38		25		83	17	25	72	70	16	72	6		14	18	15		552	15	79
July	30		25	56		46		110	27	15	100	68	36	27				25			565	12	60
Aug.		9	46	66		80		158	31		80	114	34	58							676	10	71
Sept.		50	61	100		37		195	21	30	162	107	19	126			21	16	57	3	1005	15	109
Totals	101	59	250	281	24	326	49	953	198	150	1014	731	161	902	15	73	118	211	557	7	**6180**		

During the year 175 variable stars were observed.

GENERAL NOTES.

Professor Lewis Boss, director of Dudley Observatory, Albany, New York, died on October 5, after an illness of a year and a half. He had been director of Dudley Observatory since 1875 and for several years director of the department of meridian astrometry of the Carnegie Institution. Elsewhere in this number of Popular Astronomy is given a review of his life by Professor R. H. Tucker, who was for many years associated with Professor Boss.

Professor Mary W. Whitney, director of the Vassar College Observatory since 1888, retires on a pension of the Carnegie foundation as professor emeritus of astronomy.

Dr. A. van Maanen, who for some time studied with Professor Kapteyn at Groningen, Holland and who spent last year at the Yerkes Observatory, has accepted a position at the Mt. Wilson Solar Observatory. A part of Dr. van Maanen's work will be with the 60-inch reflector, and the rest of it will be solar work with the Snow telescope.

Dr. Benjamin Boss has been appointed acting director of the Dudley Observatory, by the trustees of the Dudley Observatory, and acting director of the department of meridian astrometry of the Carnegie Institution of Washington, by President R. S. Woodward of the Carnegie Institution, pending later definite appointments.

Professor W. J. Hussey, director of the Detroit Observatory of the University of Michigan, is at present engaged in the re-organization of the Astronomical Observatory of the University of La Plata, Argentina, of which also he is director. Professor Hussey was granted eighteen months' leave of absence from Michigan last spring in order that he might carry forward the plan of co-operation between the Observatory at Ann Arbor and the similar institution in the southern hemisphere. He left for the south last June and since that time has been followed by Messrs. P. T. Delavan and B. P. Dawson, both of whom have been trained in astronomical work at Michigan. Mr. Delavan returns to Argentina where he was a member of the Carnegie expedition for the observation of fundamental stars in the southern hemisphere. The fourth member of the present expedition to the La Plata Observatory was Mr. H. J. Colliau, the Detroit Observatory instrument maker, who sailed August 20 to join Prof. Hussey and assist in the reconstruction of the instrumental equipment of the southern institution. With Mr. Colliau went a shipment of machinery, tools and supplies to equip the new observatory shop which Prof. Hussey is having built at La Plata.

During Professor Hussey's absence the Detroit Observatory of the University of Michigan is in charge of Professor R. H. Curtiss, the Assistant Director.

Doctor Sebastian Albrecht, formerly of the Lick Observatory, and more recently First Astronomer of the Argentine National Observatory at Cordoba, has been appointed Junior Professor of Astronomy in the University of Michigan.

Dr. William R. Brooks, director of the Smith Observatory and Professor of Astronomy Hobart College Geneva, N. Y., is greatly bereaved in the death of his beloved wife, Mary E. Brooks. They were married in October 1868. She was a most loyal and devoted wife; at all times full of sympathy and interest in her husband's astronomical work, and often assisted him in his observations.

The Constant of Aberration.—In the *Astronomical Journal* No. 639-640 Professor C. L. Doolittle gives the results of 22 determinations of the constant of aberration at the Sayre and Flower Observatories, during the years 1889-1911. The values of the constant range from 20″.445 to 20″.605 and the weighted mean of all comes out **20″.525,** with a probable error of ±0″.0043. The corresponding value of the solar parallax is **8″.780.**

Descriptions of 132 Nebulæ and Clusters.—The Lick Observatory Bulletin No. 219 contains a list, with brief descriptions of 132 nebulæ and clusters photographed with the Crossley Reflector by Messrs. J. E. Keeler, C. D. Perrine, R. H. Curtiss and H. D. Curtis. This list does not include the 68 objects photographs of which by Professor Keeler were reproduced in Volume VIII of the Publications of the Lick Observatory. In the introduction to the list Dr. H. D. Curtis says:

"As far as modern studies of nebular structure are concerned, it is not too extreme a statement to say that the visual observations of the past are almost valueless, even when made with powerful instruments by skillful observers. The amount of material for the study of nebula forms secured by photographic instruments of long focus is lamentably small in comparison with the number of objects still awaiting examination. These facts, and the growing interest in studies of nebular structure and distribution, make it appear that the publication of this list will be of value to students in this field."

A Theory of Novæ.—In the *Comptes Rendus* for May 20 M. Deslandres has an article on comparison between Temporary Stars and the sun, leading to a simple explanation of temporary stars. After disposing of the previous theory that a Nova is the result of a collision of two stars, or of a star and a nebula, by saying that it is difficult to understand why the displacement of the dark line is always towards the violet and always very great, which would only happen if the line joining the stars is at right angles to the line of sight, and if the body which gives the dark rays is always the one which approaches us—a criticism that was made in this magazine by Father Sidgreaves on an earlier occasion—he goes on to describe certain daily observations fo the K_3 line in the sun made with the spectroheliograph at Meudon. Speaking generally, it is possible to say that the outer envelope of the sun shows, in a small degree, the displacement of the bright line to the red, and of the dark line to the violet, which is so strong a characteristic of new stars. M. Deslandres is thus led to an explanation. A Nova is a body already cooled which has a solid crust relatively thin. Under the influence of several causes the crust breaks, and the internal incandescent gas, at first held under high pressure by the crust, makes a sudden eruption, and forms for some time an atmosphere very dense, very brilliant, having movements analogous to those

of our solar atmosphere, but much more rapid. The crust below re-forms, and the atmosphere, which is no longer renewed by the interior very hot nucleus of the star, cools, condenses, and loses little by little its light. In a word, the phenomenon of a temporary star will be simply a volcanic eruption generalized, much more extended and important than those which are occasionally produced on a restricted region of our earth. *The Observatory*, Sept. 1912.

The Perseids—Aug. 11, 1912.—There was no moon this year on Aug. 11 as in 1911, but cloudy weather hampered observations. On August 10,

THE PERSEIDS AUG. 1912.

eight Perseids were seen between the clouds. One was observed between 11:30 and 12:00 p.m. when the sky cleared favorably in the N. E. for half an hour.

August 11 was continually cloudy until 12:03, when the sky cleared up near the radiant point, and the seeing was fair until 2:40 a.m. It once more clouded up and remained so until daybreak. Between 12:03 and 2:40 101 Perseids and 24 meteors from radiants in Cassiopeia and Pegasus were counted. Thirty-five minutes were lost during this period because of complete cloudiness, so that in two hours and two minutes 101 meteors from Perseus were observed, an hourly rate of 50.

Of these 24 left distinct trails of white or green (3 green, 21 white); 29 were orange in color, 2 red. 1 blue, and the rest white; 32 near the radiant were mapped.

The rate every 30 minutes is as follows:

12:03 a.m.	12:30 a.m.	18	clouds	5 min.	7 others
12:30	1:00	11	"	10 "	4 "
1:00	1:30	19	"	10 "	10 "
1:30	2:00	24	"	5 "	3 "
2:00	2:40	29	"	5 "	
$2^h\ 37^m - 35^m = 2^h\ 02^m$		101		35 "	24 "

By magnitudes:

Mag.	0	1	2	3	4	5	6	
No.	4	9	18	21	18	9	22	101

Compared with the last 12 years they were fainter and fewer than any year except one. Comparing the last two years with 1912:—

Aug. 11, 1910,	12.00 — 2:30	186	clear.
11, 1911,	12.00 — 2:30	70	moonlight.
11, 1912,	12.03 — 2.40	101	part cloudy.

ROBERT M. DOLE.

Mt. Weather, Va.

On the Motions of the Brighter Stars of Class A in Relation to the Milky Way.—In the *Lick Observatory Bulletin*, No. 212, Mr. H. C. Plummer gives the formulæ and data used in the investigation of the motions of the stars of spectral Class A, to which we referred in a note on page 261 in the April number of POPULAR ASTRONOMY. He finds that the assumption that these stars are moving parallel to the plane of the Milky Way yields reasonable parallaxes in the majority of cases. Out of the list of 172 stars, 38 yield negative parallaxes. For 25 the parallax has been determined by observation and in only five cases is the difference between the hypothetical and the observed parallaxes impossibly large.

Arranging the stars in groups having approximately common motion Mr. Plummer finds that 112 stars will fall into nine groups as follows:

Stream	No. of stars	U	V	W	R	A	D
		k	k	k	k	°	°
1	16	+ 0.9	+21.3	− 3.9	21.7	87.6	−10.4
2	19	+ 2.0	+37.5	+ 4.8	37.9	87.0	+ 7.3
3	16	− 3.4	+12.0	+16.1	20.4	105.8	−52.1
4	9	− 8.0	+25.7	−19.2	33.1	107.3	−35.5
5	22	+ 3.7	+ 8.0	− 4.0	9.7	65.2	−24.4
6	13	+ 6.7	− 6.2	− 4.0	10.0	317 2	−23.6
7	7	+10.1	+ 5 2	− 7.3	13.5	27.2	+32.7
8	4	+ 9.4	−15.5	− 2.5	18.3	301.2	− 7.8
9	6	+ 0.3	−23.9	−23.5	33.5	270.7	−44.6

In this table U, V and W, are the rectangular components of the star's motion along the axes in the direction of 0 hours and 6 hours in the plane of the equator and toward the North Pole, R is the resultant velocity through space relative to the sun, A and D the right ascension and declination of the convergent of the group.

When the corrections for the sun's motion $X = 0$, $Y = -14.5$, $Z = +8.4$ are applied to the coördinates of motion of the groups with reference to the entire system of stars become as follows:

Stream	No. of Stars	U+X	V+Y	W+Z	R′	A′	D′
1	16	+ 0.9	+ 6.8	+ 4.5	8.2	82.5	+33.3
2	19	+ 2.0	+23.0	+13.2	26.6	85.0	+29.8
3	16	− 3.4	− 2.5	− 7.7	8.8	216.3	−61.0
4	9	− 8.0	+11.2	−10.8	17.5	125.5	−38.1
5	22	+ 3.7	− 6.5	+ 4.4	8.7	299.6	+30.4
6	13	+ 6.7	−20.7	+ 4.4	22.2	287.9	+11.4
7	7	+10.1	− 9.3	+15.7	20.9	317 4	+48.7
8	4	+ 9.4	−30.0	+ 5.9	32.0	287.4	+10.6
9	6	+ 0.3	−38.4	−15.1	41.3	270.5	−21.3

It will be noticed that groups 1 and 2 are moving in the same direction, the one with over three times the velocity of the other. The direction is close to that of the Taurus stream. Groups 6 and 8 also have the same direction and different velocities, the direction being close to that of the Ursa Major stream.

Comparing these results with the "two-drift" theory Mr. Plummer finds that the average of the first five groups agrees very well with "Drift I", the coördinates of the convergent coming out $A = 89°.7$, $D = -17°$, while the mean of all former researches places it at $A = 89°$, $D = -13°$. The average velocity of the 82 stars relative to the sun is 21.2 kilometers

Corresponding to "Drift II", however, Mr. Plummer finds only his stream 9, with 6 stars, and these yield a high velocity, 33.5 kilometers, while the stars of "Drift II" are commonly supposed to be moving with a very low velocity.

Eclipse of Oct. 9-10, 1912.—A cable message has been received from Professor Perrine, Director of the Cordoba Observatory, from Christiania, Minas Geraes, Brazil, "Rain." This appears to indicate that observations of the Eclipse of the Sun on October 9-10 were prevented by bad weather.

Numerous observations of Gale's comet and its spectrum have been obtained here and elsewhere.

EDWARD C. PICKERING.

Harvard College Observatory, Bulletin 503.
Cambridge, Mass., U. S. A., October 15, 1912.

Practical Astronomy with the Unaided Eye, by Hector Macpherson, Jr., F. R. A. S. Published by T. C. and E. C. Jack, London and Edinburgh. This is a booklet of 94 pages, intended for the ordinary reader who wishes to study the constellations without a telescope. Price 6d net.